May 2014

# Drones, UAVs, and RPAs

Daniel Charles Fox
*Worcester Polytechnic Institute*

Muhammad Ehtisham Abid
*Worcester Polytechnic Institute*

Syed Shehroz Hussain
*Worcester Polytechnic Institute*

Travis Lee Austin
*Worcester Polytechnic Institute*

# Drones, UAVs, and RPAs

## An Analysis of a Modern Technology

An Interactive Qualifying Project Proposal
Submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
In partial fulfillment of the requirements for the
Degree of Bachelor of Science
By

M. Ehtisham Abid

Travis Austin

Daniel Fox

Syed Shehroz Hussain

May 1, 2014

Project Advisor:

Professor Kent J. Rissmiller

## Abstract

Despite the fact they were invented more than a century ago, drones, or UAVs, have only recently become a widespread technology. Lower building costs coupled with non-traditional military actions have caused the use of UAVs to escalate profusely. Due to this marked increase in application, a host of new problems and technicalities have created a need for new legislation in order for UAVs to be a useful and morally positive technology. It is the purpose of this paper to investigate the place of UAVs in the modern world and make recommendations to maximize the positive change this machinery can bring. This is accomplished by: analyzing the technical abilities and shortcomings of UAVs, point out possible improvements, and offer an educated guess into the future of UAV technology; examining the domestic impact of UAVs, the government's resulting legislation and the possible future economic effects; scrutinizing the international implications of a new technology and critiquing how several governments are using UAVs improperly; and finally by considering the humanitarian impact of the current UAV programs. Without these considerations and solutions, their misuse will hurt the potential benefits that UAVs offer and drive the public against them.

## Executive Summary

There are two main types of Remotely Piloted Aircraft (RPA): fixed wing and rotary wing. A fixed wing aircraft, like an airplane, can fly faster and usually farther, but has less maneuverability than a rotary wing aircraft, like a helicopter. There is also a wide range of Unmanned Aerial Vehicles (UAV), ranging from a few inches in length to over 130 feet (the size of a Boeing-747 plane). Despite this wide range, the majority of civilian UAVs are built by hobbyists and are quadcopters, with blades spinning around four rotary points to allow a high degree of stability; these craft are usually one cubic foot in size. The various uses of UAVs include: geological/archaeological surveying (which includes map building and 3D modeling), geomagnetic surveying (finding subterranean materials), guiding (MIT uses a UAV as a tour guide), package delivery (the plan unveiled by Amazon), pizza delivery, pipeline monitoring, advertising, journalism, farming, photography, scare-crowing (in Canada), real estate, hunting, private security, scientific research, disaster cleanup, environmental protection (used to track the health of endangered species), security, border patrol, traffic monitoring, firefighting, weather tracking, search and rescue, police backup, low cost military action, aerial target practice, maritime patrol, and intelligence gathering. The four groups that use UAVs are: militaries, governments, hobbyists, and commercial users. While commercial pilots and manufacturers are currently not allowed to make money from UAV use according to the Federal Aviation Administration (FAA), this is liable to change. Although there is much public support in the United States for military UAV use against terrorist organizations, many people are uncomfortable with domestic use.

UAVs, or drones, should not be referred to by either name. UAV means ‘Unmanned Aerial Vehicle’ and most drones are neither unmanned nor vehicles. *Drone* has a poor

connotation mostly due to their depiction in the media and science fiction. Thus, these machines should be referred to as RPAs or remotely piloted aircraft, as it reminds the public that these machines do in fact have a human pilot.

The three main physical characteristics that define RPAs are the primary sensor, communication device, and controller. The vast majority of RPAs use a camera or another type of imaging device as their main sensor. These imaging sensors can be: high definition, thermal imaging, Light Detection and Ranging (LIDAR), ultrasonic, and hyperspectral. Other sensors include a Global Positioning System (GPS) and barometers. These sensors would be useless without a communication device to relay information and instructions to and from the ground controller. This communication can be achieved by: satellite, radio, Bluetooth, and wireless Internet. While wireless Internet or Wi-Fi is the most popular choice for non-military RPAs, it is not without its flaws, most notably its notorious lack of reliability. This means that RPAs sometimes fall out of the sky because they lose connection with the ground controller, a rather dangerous situation. The final important aspect of an RPA is the controller, which is either an onboard full computer for larger RPAs or a microcontroller for others. These microcontrollers either come preprogrammed or allow the users to add their own code, with many online sources to help them.

With a wide variety of styles, sizes and types, it is worrying that there is not a clear classification system for RPAs. The United Armed Forces, the Navy, the Air Force, and the Army, all have their own classification systems with varying degrees of confusion and there is no civilian classification system at all. The issue is that these military classes were based on specific RPAs, meaning the criteria are nonlinear. Thus, there is a clear need for a clean and simple classification system for both the armed forces and domestic use. Based on analysis of the current systems and FAA suggestions, the domestic RPA classes should be based on maximum altitude of the RPA because laws are already in place based on the height of an aircraft. The military should base their class system on ‘use’ as there is a very large difference between an RPA firing missiles and an RPA carrying cargo.

Currently, RPAs are fraught with technical issues and errors. While military RPAs still need a great deal of work, the fixes for domestic RPAs are relatively simple. The main reason domestic RPAs fail is because they lose connection with the ground controller or they run out of power. This can be solved by introducing a semi-autonomous system on board that will either hover the RPA when connection is lost or land the aircraft in either case. Hacking, another prominent issue, can be fixed by encrypting control signals. While this can be expensive and slow down RPA communication, it is a necessary addition as RPAs become more popular.

The public should also be educated on the role of these machines in the modern world. Many people are unfamiliar with how simple and cheap it is to make or buy an RPA as the media’s focus has been mainly on military RPAs. The best way to deal with the public’s current RPA phobia is to show the economic benefits these devices can provide.

The future of RPAs, though unknown, can be predicted with reasonable accuracy. Since batteries are a limiting factor in RPA usefulness and design, it is possible the world will see better batteries quite soon. Several innovations in the field of battery design, such as a sodium-ion base and carbon nanotube casing, are showing great promise in improving batteries. In the future, RPAs will also have a less traditional design as current models are based on manned aircraft which must conform to human comfort.

The FAA has failed to meet many, if any, of its deadlines as outlined be FAA Modernization and Reform Act of 2012 (FMRA). FMRA had very specific dates and objectives for the FAA to accomplish; some of these time frames could be considered small. However, FMRA was designed to speed up the FAA's progress after years of inaction. Despite this intent, the U.S. Congress left several key details out of FMRA, such as privacy, that have slowed progress and caused delays. However, most of the delays the FAA has dealt with have not been directly because of Congress' silence. Instead the FAA has had internal restructuring issues and has focused its attention on other projects like Next Generation Air Transportation System (NextGen), causing most of the failures to meet initial deadlines. These initial failures have subsequently caused further failures for goals that relied on initial success. One of the initial failures was the issue of privacy which the FAA looked at and decided to ignore, and focus only on safety in the National Airspace System (NAS) which is their primary task. Part of their process to ensure safety was to institute a blanket ban against all RPA applications for commercial use. This ban has recently lost its first case in court and has fundamental issues that will continue to weaken the ban's power in a short to midterm timeframe. The FAA is attempting to institute its own rules before the ban is completely overturned or ignored and RPA flights begin without any regulation.

Most of the safety problems the FAA faces with RPAs have yet to be dealt with. The FAA has outlined what needs to be developed in order to ensure safety in the NAS. Unfortunately, this integration will require new technology as the current level is lacking. In order to allow RPAs to fly domestically, the FAA would like to have the ability to achieve full integration into the NAS which is a difficult task. The primary fears for the FAA are about RPAs losing contact with ground control and not being able to navigate away from other aircraft. This is a long term goal that the FAA does not feel it can meet in less than five years. The FAA has not outlined a lot of specifics with regards to small RPAs that would operate below minimum manned aircraft limits of 500 feet. This is arguably the size and range that the majority of RPAs would operate at in the short to midterm time frame of one to five years.

The economic benefits of RPA integration into the NAS are one of the primary motivators for pushing the FAA to accelerate the process. Across the country, the economic impacts have been estimated to be in the range of several billion dollars and over 100,000 jobs by 2025. The initial estimates had a few states taking most of the benefits, but since that time, several other states have made internal adjustments. These states have made strides in order to become more significant members of the future RPA industry. This will inevitably shift where RPA industry goes and where the majority of economic benefits fall in terms of tax revenue and jobs.

Agriculture is one of the largest economic fields in America and also one of the primary uses for RPAs. Future uses may be discovered later that are impossible to predict now and several other uses already exist such as wind turbine inspections, however agriculture has key factors that will make it a dominant use of RPA technology. Factors like the ease of integration with existing technology, and large scale benefits from relatively small investments in RPAs will cause RPAs to become a basic component of farming in America. RPA use in American agriculture will definitely cause an increase in farming efficiency that will ripple throughout the world, increasing the global food supply.

RPAs are a major public concern with regard to privacy as existing privacy laws were not designed with such cheap and automatic aerial vehicles in mind. Congress has not issued any legislation and was silent on the FAA’s role in the issue; consequently the FAA did not deal with the issue. These types of inactions leave a vacuum that will need to be filled by either the courts, or local and state legislators. Local and state legislators have already begun to act, but this will create a patchwork of privacy laws as each group implements conflicting legislation. A comprehensive privacy ruling will need to come from the Supreme Court, but this will take additional time. It is unlikely that RPA use will proliferate until the issue of privacy is settled in a comprehensive manner even after the FAA's final rules are issued. Congress would be able to pass legislation that would serve as a solution to privacy concerns in an open and nationwide way, but it is unlikely they will decide on the issue any faster than the Judicial branch's rulings.

RPAs, or drones, have been widely used by the United States' military in the War on Terror. While inside the USA, there is a general support for the use of drones by the US military and CIA, polls conducted abroad show that the majority of the people are against drones. This holds true in more than 30 nations, with only Kenya, Israel and the United States' publics supporting the American drone campaign. This unpopularity of drones can be attributed to different issues related to drones like morality, civilian casualties, suspected rise in militancy, violation of human rights and disregard of international humanitarian laws.

The USA has used drones internationally in countries like Afghanistan, Pakistan, Somalia and Yemen to target operatives of Al Qaeda, Taliban and other terrorist organizations from air bases in the United States of America and other US controlled locations, like Djibouti. The US government, more specifically the Central Intelligence Agency (CIA), claims that drone strikes are precise and cause either no civilian casualties or very few civilian casualties. However, evidence suggests that this is not the case, resulting in a lot of criticism about the morality of drone use. Opponents of drone strikes argue that drones are counter-productive and cause a rise in militancy in areas like the tribal regions of Pakistan when innocent people are killed in the process. Moreover, the ease of targeted killing with drones gives immense power to operators and violates the Universal Declaration of Human Rights as well as International Humanitarian Law which gives protection to civilians and rescuers inside and outside of a war zone.

The better alternatives to drone strikes in Pakistan and other areas outside war zones are negotiations and dialogue with local leaders such as tribal elders. Through this tactic, militancy due to civilian casualties can be slowed down and possibly halted, allowing peace to be established. This, in turn, can help the goals of the U.S. War on Terror while also complying with the United Nations (UN) human rights agreements.

A war can be launched on another state for several reasons, and results in either occupation or annexation. *Occupation* means the control of the region during a war through the use of force; whereas *annexation* of a region means actual and recognized possession of a territory. *War Zone* refers to an area where a war is going on. Civilian killings in a war zone are not rare; however, killings through military operations and drone strikes in a non-war zone are a violation of national sovereignty.

The benefits affiliated with drone strikes will start an arms race amongst different countries; this is the reason why we need a legal framework for drone use as it becomes more widespread. Drones are not illegal under international law but different countries are worried about civilian casualties, complete dependency of a strike on intelligence information, no accountability and less transparency of drone program. Investigations are being carried out by the United Nations regarding improper drone use with the intent to formulate effective legislation.

The UN should form a ‘wanted’ list of militants and hand over the responsibility of eliminating them to host countries and, if a country demands, further financial and military help can be given. However for countries which are not willing to cooperate, economic sanctions can be used to pressure them. This will help solve legal issues related to drones such as violation of sovereignty. If drones are used under the international regulations, they can play a vital role in national security of each state.

# Table of Contents

## Table of Authorship

- The Technical Aspects of Drones
  - Written by Daniel Fox
- Domestic RPA Use
  - Written by Travis Austin
- The Humanitarian Implications of Drones
  - Written by Syed Shehroz Hussain
- The International Perspective
  - M. Ehtisham Abid
- All Other Sections Were Written Jointly

## Introduction

In July 2011, in a small county in North Dakota, an ownership dispute about stray cattle had been brought before the local police. The sheriff took action the next day, planning to arrest the accused, but had no way of knowing if they were still armed. Fortunately, he called the nearby Grand Forks Air Force Base for assistance, and they sent a drone to assess the situation. After the drone confirmed that none of the suspects were armed, the local authorities were able to move in and arrest them without any risk of bloodshed. The defendant claimed that the case was unjust due to the illegal use of drones and proceeded to take legal action against the police. This was the first time an arrest had ever been made with the assistance of a drone (Subbaraman, 2013).

This case is an example of how drones are integrating with different aspects of society; the lawsuits that followed gives further insight into the controversy surrounding drones. In addition to law enforcement, drones are being used for military strikes, environmental protection, journalism, scientific research, disaster relief, border security, and international espionage. Regardless of people's approval or disapproval of how this tool is being implemented, it is clear that drones are now a significant force in the modern world with new uses being discovered. As Mayor Bloomberg of New York City remarked, “You can’t keep the tides from coming in. We’re going to have more visibility and less privacy”, referring to the use of drones as a tool for surveillance (Moore, 2013). If not properly controlled, drones will be used to invade individual privacy and it is now up to the people of the world to make sure drones are used responsibly. While the value and morality of drones is hotly debated, drones can greatly benefit humanity if their development is properly handled. This paper examines several issues and topics regarding the place of drones in the modern world. These topics include the technical naming and classification of drones, as well as the education of the public regarding the realistic abilities and uses of these devices. Balancing the commercial promise of RPAs against the FAAs concerns over privacy and safety is a key domestic issue also discussed in this paper. The issues of public perception of drones, their role in the military, and their morality of use are addressed as well. Finally, drone strikes are analyzed under international law and a resolution for a U.N. position is proposed. These important issues need to be discussed before UAVs can find their place in present-day society.

Despite the bright opportunities drones provide, there is a concern that drones are currently causing too many problems. Mechanically, drones are both too easy to build and too easy to hack.[1] Anyone, despite a lack of technical knowledge, can build and operate a drone with little economic or time constraints. The sensors drones are using up to this point are infantile in their application and can be better applied (Weinberger, 2012). For example, while military drones are impressive, the sensors and designs currently used were originally meant for manned aircraft and the transition into unmanned systems was not seamless. Very often designers would simply house the computer systems in the cockpit where the pilot would usually reside. Current drones are often compared to early cars as their design is bulky, inefficient, and clearly capable of improvement. The mechanical systems of drones are still very limited; for example, drones can only be flown in very specific weather patterns (Abe, 2012).

[1] (Kingcope 2009; Sharkey 2012; BYOD 2013)

Regardless of these mechanical limitations, drones are currently active in the United States, for both commercial and governmental use. The Federal Aviation Administration (FAA) has been tasked by the United States' Congress with developing domestic drone policy. While it listens to the many parties hoping to influence the new rules in their own favor, the FAA must also try to impose restrictions on individuals and organizations already utilizing drones (Federal Aviation Administration, 2013). Even with imminent stricter regulations, drone users have continued to develop operations and uses (Epatko, 2013). It is clear the United States still needs to develop a comprehensive and effective domestic drone policy with practical enforcement.

As the United States has tried to implement a clear domestic policy through the FAA, it and other nations have faced issues abroad regarding international drone use. These problems currently include the use of drones for espionage and assassination with little to no regard for national sovereignty or international law. This has not been helped by very unclear and mixed opinions offered in the United Nations (UN) with regards to the U.S.A.'s drone policies. For example, according to Ed Pilkington and Ryan Devereaux of *The Guardian*, "Representatives from a slew of nations, including Brazil, China and Venezuela, lined up to berate the Obama administration for its intensive use of drone strikes" (2013). These differing opinions on international drone uses raise tensions between countries, and can give rise to international conflict, like the Pakistani-American standoff after several cases of drone attacks. In response to the drone strikes, protesting Pakistanis have vowed to hinder NATO supply routes heading to Afghanistan (Masood & Mehsud, 2013). According to *Geo News,* Pakistan's leading news channel, Pakistan's interior minister Chaudhry Nisar stated, "drone strikes in the country's tribal areas may give rise to a conflict between the United States and Pakistan" (2013).

Besides the outcry in international symposiums like the UN against drone use, there is an increasing criticism of the civilian casualties and collateral damage associated with drone strikes. Drones form a recognizable part of the United States' War on Terror with a marked increase under the Obama Administration (Byman, 2013). However, it is unclear if drones are actually an effective tool in limiting enemy militancy. A drone attack is usually successful in killing the intended target, a Taliban leader or an Al-Qaeda figure, but it also kills a notable number of innocent civilians according to many human rights organizations (Whitlock, 2013). Robert Gernier, who headed the CIA's counter-terrorism center from 2004 to 2006 and was previously a CIA station chief in Pakistan, said that, "we have been seduced by [drones] and the unintended consequences of our actions are going to outweigh the intended consequences" (Glaser, 2013). Since drones have become a source of terror for many non-combatants in places like the tribal areas of Pakistan and Yemen, they might do more damage than good to the American War on Terror. Surveys suggest that these attacks may be creating more enemies than removing enemies from the battlefield. According to Pew Research Global Attitudes Project, a 2012 poll found that 74 percent of Pakistanis viewed the United States as their enemy which is higher than the 69% recorded in 2011 and 64% measured in 2009, likely in part because of the current drone campaign (Byman, 2013; "Pakistani Public Opinion," 2012). Similarly, in Yemen, as the scholar Gregory Johnsen has pointed out, drone strikes can garner the enmity of entire tribes (Byman, 2013). Regardless of the rising anti-American sentiments, some US officials claim that drones strike are effective in limiting militants' ability to organize and operate (Byman, 2013). It is currently unclear if this is true. While the issues confronting drones are numerous, the world can and will substantially gain from the responsible use of drones.

This research paper seeks to closely examine the role of drones, to make recommendations that would restrict negative drone use, while still allowing the potential for growth in areas that could benefit society. Drones are a new form of technology and regardless of personal preference; they are and will become an active force in the modern world. The best way to utilize drones is to realize they are not weapons, but simply tools that can and have been improperly used. This paper will try to serve as a guide for drone use by the United States, private citizens, and the numerous countries of the world.

**Background Information**

Before attempting to solve the problems vexing drones and their uses, it is important to first understand what a drone is and how they came to be. A drone refers to an unmanned aerial vehicle, or UAV. A UAV is defined as any pilotless flying machine controlled autonomously or by ground-based operators. This does not include remote controlled, or RC, planes which are required to remain within visual range of the ground controller because they do not have the sensors necessary to fly semi-autonomously. A UAV is a subset of an unmanned aerial system, or UAS, which refers to the UAV and all connecting ground-controllers, satellites, radio, or additional equipment. Unfortunately, there is a second definition for UAS that has recently appeared further complicating the terminology; a UAS is now also used to refer to any non-military UAV. The United States Air Force is attempting to rebrand UAVs as remotely piloted aircraft, or RPA, to remind the public that there is still a human controller behind the increasingly robotic systems (Parsons, 2013).

The word drone originally referred to: a low humming sound, a laborer that works for others, or a male bee (Oxford, 2013). The military adopted the name ‘drone’, using it to refer to the UAV's sound as well as their simple and repetitive design. The media quickly accepted the name ‘drone’, finding it much simpler and more accessible than the technical term, UAV, and leading to its continued use today.

The first known use of a UAV was around WWI when an English scientist named A.M. Low attempted to develop an anti-Zeppelin, radio-controlled flying bomb (Taylor & Munson, 1977). This would serve as a model for the modern cruise missile which is a type of UAV. As time went on, different uses for UAVs appeared. More sophisticated missiles were produced, however the first drone, as currently understood by the public, would not be seen until the mid-1930's, when the Queen Bee drone was developed for target practice (Rivera, 2013). UAVs would continue to only exist as missiles or target practice until 1946 when drones were used to collect radioactive data after nuclear tests (Hess & Winchester, 1998). As the Cold War continued, there was a marked increase in the need for stealth planes for espionage and intelligence gathering leading to the production of stealth planes. When a U-2 stealth plane was shot down over the USSR, the pilot was taken prisoner thus promoting a need for unmanned surveillance aircraft (Pedlow & Welzenback, 1992). Then during the Vietnam War, surveillance drones' usefulness was fully recognized to help combat guerrilla warfare, stimulating technological growth (Shaw, 2013).

As electronics and computers became more sophisticated, the United States began to expand the role of drones, arming them with missiles. These armed drones were then utilized during the 1990s in Iraq but they were not extensively used until after the 9/11 terrorist attack.

In November of 2002, the role of drones in warfare was forever changed when the CIA used a predator drone to kill 6 al-Qaeda members in Yemen. Not only was this the first time a drone strike had killed someone without supporting soldiers on the ground, but one of the operatives killed was also a US citizen. In fact, it was also the first time a predator drone had been used outside of Afghanistan (Pincus, 2002). This single act alarmed American citizens, as drones had now been used against one of them and caused an international uproar, as it had violated Yemen's sovereignty.

In contrast, drone technology was and still is adapted for non-military uses like border control, geological survey, transportation, journalism, package delivery, as well as others. For instance, in 2013, when the Haiyan Typhoon hit the Philippines, a British photographer, Lewis

Whyld, launched a drone to get aerial shots of the damage, and was able to view places that were otherwise inaccessible. His drone was also useful in spotting two bodies that were later recovered (Kaufman & Somaiya, 2013). A journalist, Karl Penhaul, along with CNN, also used a drone to show the magnitude of the devastation to the world (2013). These aerial videos gave a broader perspective of the destruction. It is quite likely that the powerful images provided by the drones aided the relief effort for the Philippines.

**Methodology**

There is a need for a comprehensive document that addresses all of the facets of rising drone technology. This paper seeks to help fill this gap by gathering information from documents, testimony of experts, legal arguments, as well as news reports and combine them into one all-inclusive resource. This research paper will address issues such as: protecting the rights of private individuals, corporations, and sovereign nations while still utilizing drones both inside and outside the United States. The document also addressed the need for a comprehensive and fair international agreement on military drone applications, and the need to educating the public about ongoing drone activity.

This research paper uses online blogs, newspaper articles, published statistics, and opinion pieces. As there are varied opinions on the morality and uses of drones, it is important to seek multiple viewpoints. We realize there are very few impartial sources about such a controversial topic and therefore we will need to treat every source with a healthy amount of skepticism. An example of the differing reports and statistics is the number of civilian casualties in predator drone strikes reported by the United States government and various humanitarian groups.

Through research and personal interviews, we answered several questions, such as what are the actual civilian casualties caused by drone strikes. As the topic of drones is controversial as well as important in the United States' War on Terror, government officials were reluctant to give an interview, opinion or information for this paper. By talking to Ayesha Gulalai Wazir, Member of Pakistan's National Assembly from the region of Waziristan agency, and Jennifer Gibson, a US lawyer working for Reprieve, a non-profit organization (NGO) based in the UK, we also analyzed the legal and humanitarian aspects of drone use inside and outside of a war zone. Using public polls, research reports and international laws, we studied the impact of issues related to drones like morality, civilian casualties, increases in militancy, violation of human rights and sovereignty of nations.

Moreover, we interviewed several leading legal experts in the field of UAVs. These interviews provided a better understanding of the legal aspects of drones from the perspective of prominent lawyers, like Diana Cooper and Faye Jones. Additional sources included the transcripts from congressional subcommittees on the topic of drones. These transcripts give us access to opinions and arguments from leading experts on the legal questions surrounding drone use, especially the conflict with privacy rights. We also researched what the FAA has done as well as what they are tasked with doing before their 2015 congressionally mandated deadline. Looking at the response to the FAA's request for public comment gave us differing opinions on a number of domestic issues, in particular privacy. Combining these documents and interviews from experts in legal fields with UAV industry leaders, like Dr. Jerry LeMieux and Dr. Barry Milavetz, gave us a balanced argument on where drones belong inside America.

Throughout this paper, we sought to both educate the public about the realities of the current state of drone use as well as the current and future technological capabilities of drones. To accomplish this, we contacted several groups and individuals for their opinions and experiences. These methods provided us with a diverse set of viewpoints from experts that will enable us to better understand and suggest solutions to some of the numerous problems surrounding drone use in the modern world.

We would like to thank everyone who took the time to talk with us about this important. There are many people excited or worried about drones, and it is important for everyone to share their insight.

## The Technical Aspects of Drones

### Technical Overview

Like all aircraft, there are two main types of UAV: fixed wing and rotary wing. Fixed wing UAVs are similar to traditional airplanes in that they have one or more wings used to create lift, with propellers or engines to power the design. These machines can generally only move forward, but a tail control can allow the craft to change its heading. Rotary wing aircraft, on the other hand, rely on spinning blades centered on a rotor to keep the machine in flight. The most common type of rotary wing aircraft is the helicopter (Kendall, 2012). Rotary wing UAVs usually have more than a single rotor, using four or eight different rotation points. The multi-rotor UAVs can keep the machine more level, but use a great deal more power, meaning that most are smaller than what a human could fit into.

There is a wide range of different sized UAVs currently in the world. The smallest UAV was inspired by how a hummingbird flies and is less than three inches long, weighing less than half an ounce (<10 grams) (Covert, 2008). In contrast, the largest UAV is the RQ-4B Global Hawk, a $35 million UAV with a wingspan over 130 feet (~40m) (U.S. Air Force, 2008). Despite the immense difference is size, scope and use, these two aircraft are often classified as the same, simply referred to as drone.

While there is a wide range of UAVs, the vast majority are the same size. The vast majority of hobbyist-built and commercial UAVs are in two distinct styles. The first is a quadcopter, a four bladed rotary wing UAV, with the sensors and controller in the middle with the rotors on the end of four arms. These machines are usually around a foot (0.3 meters) in height, a foot in length, and half a foot high (RCgroup, 2012), but can vary quite a bit in material, motor strength, and wing length. When hobbyist UAVs are mentioned, it is usually this type of aircraft and two of the most well-known are the Parrot AR-2, and the Draganflyer X-6, two pre-made UAVs available for $300 and $7,500 respectively. The large change is price is mostly due to sensor cost, as the sensitivity and resolution of these sensors can widely vary. The other main commercial style is simply a Remote control (RC) plane with a nose mounted camera. These crafts are also called *First Person View RC* or FPV-RC because they provide the ground controller with the UAV’s perspective.

The military has a variety of UAVs, but their most famous model is the MQ-9/RQ-9 Predator, a $20 million machine that has been operating since 2005 (UcGI, 2009). In fact, this UAV has at least eight different variants with uses ranging from data collection, to targeted bombing with other classified applications (U.S. Air Force, 2010). The armed versions of this drone usually have two Hellfire Missiles, capable of steering and destroying armored targets. The Predator, while designed by the United States of America, is used by five countries including Italy, Turkey, the United Arab Emirate, Morocco, and the USA. Inside the United States, the following agencies and groups control at least one Predator drone: Customs and Border Protection, Air Force, Air National Guard, Air Force Reserve Command, and the Central Intelligence Agency, or CIA (Baglolo, 2014). While the United States military has UAVs ranging from the backpack sized Dragon-Eye to the supersized Global Hawk, the most well known and most notorious is the Predator drone.

With the many different sizes, UAVs boast many different uses. These various applications of UAVs can be divided into commercial and governmental for convenience. The commercial operations include: geological/archaeological surveying (which includes map building and 3D modeling), geomagnetic surveying (finding subterranean materials), guiding

(MIT uses a UAV as a tour guide), package delivery (the plan unveiled by Amazon), pizza delivery, pipeline monitoring, advertising, journalism, farming, photography, scarecrowing (in Canada), real estate, hunting, private security, and scientific research. The governmental uses include: disaster cleanup, environmental protection (used to track the health of endangered species), security, border patrol, traffic monitoring, firefighting[2], weather tracking, search and rescue, police backup, low cost military action, aerial target practice, maritime patrol, and intelligence gathering.[3] At Least 50 different countries are currently using UAVs (Horgan, 2013). The government, however, is not the only group to use UAVs.

It is important note many different groups use different UAVs for various activities. These four groups are: hobbyists, commercial pilots and manufacturers, the police, the intelligence gathering agencies, and the military. The hobbyists, as their name implies, build and fly UAVs to learn and as a fun activity. The commercial pilots are attempting to fly and build UAVs for profit. Unfortunately, many of these companies and individuals have been hampered by the Federal Aviation Administration, who is fining those who use UAVs commercially before their regulations have been written into law. There is much debate into the legality of these fines, and some have been dismissed in court (Carvey, 2014). The third group of UAV fliers is the police, who hope to use UAVs to assist searches, as well as back up officers in emergencies. There is currently a great deal of controversy into the legality of use and whether use violates privacy. This issue is discussing length later in the paper. Intelligence gather agencies, most notably, the CIA, have been using UAVs for espionage and assassination. While morally

---

[2] A volunteer in Connecticut used his personal UAV to monitor an industrial fire (Global Research News, 2014)

[3] Krasny, 2014; Corbett, 2014; Lallanilla, 2013; Handwerk, 2013; Carroll, 2014

ambiguous, drones offer a low-cost, low-risk, way for the United States to fight the War on Terror. The final group to use UAVs is the world's militaries, with the United States, India, Israel, Turkey, and France with the largest known number of drones in that order (Rogers, 2012). It is likely this data is inaccurate, as many countries are unwilling to share how many and what type of UAV they have in this growing arms race. What is known is that the military uses UAVs to: support ground troops, provide tactical data, strike remote locations, patrol wider areas, and find enemy bombs. The military's use of drones, while less controversial than the CIA's programs, is still a fiercely debated topic, as there is a further disconnect between the pilot and the target. These groups will continue to use drones and it is important that they do so in a responsible manner.

Public opinion of UAVs differs from country to country, use to use, and day to day but the general feelings stay relatively the same. Roughly 55%-66% of Americans approve of the US's use of drones in the War on Terror, but this sentiment is not felt around the globe.[4] Only 45% of Germany, 39% of Britain, and 25% of Japan share the US's use of drone strikes (Stokes, 2013). The American public is also quite divided on domestic UAV use; both commercial and police use makes the public uneasy. Only 57% of people were supported allow UAVs in the United States, citing safety, regulatory, and privacy concerns (Eyerman, 2013). This is largely due to the public's ignorance about UAVs. In the same survey where US citizens expressed these opinions, only 54% claimed to know more than a little about UAVs. This public should know more about UAVs than their use in warfare, the most common application portrayed in media.

[4] (Brown & Newport, 2013; PewResearch, 2013; Rasmussen, 2012)

**Naming the Drone**

Currently, there are a variety of terms and acronyms all referring to the same type of remote-controlled flying machine with sensors. These terms and acronyms for this technology include: drone, UAV (Unmanned Aerial Vehicle), UA (Unmanned Aircraft), UAS, (Unmanned Aerial System), RPA (Remotely Piloted Aircraft), RPV (Remotely Piloted Vehicle), and ROA (Remotely Operated Aircraft). As laws are being written and this technology becomes more widespread, there is a clear need for a single prevailing term that is both comprehensive and well received.

The most common term for this technology is ‘drone’, and will be used during this paper, but this serves as a poor example of what this technology is. As previously stated, the term *drone* is used because of the original aircrafts’ similarities to bees, most notably a low humming noise. Unfortunately, there is a widespread stigma against drones for two main reasons; the first reason is the role of the most widely known UAV, the MQ-1 Predator Drone. “The public reacts badly to the idea of drones. They have associated the word ‘drone’ with the drones used in war... we have to stop using that word [drone],” (personal communication, March 4, 2014). The Predator drone is primarily used by the United States’ Air Force and Central Intelligence Agency (CIA) to assassinate or spy in several countries, most notably in Afghanistan, Iraq, and Pakistan and has become the public’s image for UAV misuse. Because this is the most widely known drone, the word is now associated with warfare and assassination instead of the numerous other applications. Another frequent occurrence of the word *drone* is in science fiction where it is commonly used as the antagonist’s forces; the lack of a human pilot makes UAVs ideal for such a role as the inhuman evil. This has not been helped by well-known violent video games such as the Call of Duty series, which use drones as a constant overhead machine equipped either for spying or shooting missiles. Because of this unfortunate stigma, it does not make any sense for this technology to be referred to as drones. As stated by Don Roby, Aviation Chair of the IACP (International Association of Chiefs of Police), “drone is a dirty word” (personal communication, March 3, 2014).

The most common acronym for this technology is UAV, but this is actually a poor description of what these machines are and what they do. The use of the word ‘unmanned’ leads to confusion about the actual autonomy of these machines. While all drones have sensors, they also have ground operators. At most, some have set-point and autoland functions, meaning they are only semi-autonomous. ‘Unmanned’ makes it appear as if there is no human element involved in the control of drones, which sounds outlandish and quite frightening to a large number of people (Stangley, 2013). The other issue with using the acronym UAV is that the majority of drones are not vehicles which are defined as: means by which things or people are transported (Merriam-Webster, 2014). While some drones are used to transport cargo, such as the Kaman K-Max, many more are used for data collection, covering a range of data from terrorist activity to crop health (Kaman, 2014). Thus, UAVs are usually not vehicles, making the term nonsensical. Despite the fact they are neither unmanned nor vehicles, drones are commonly referred to as UAVs and will be during part of this paper.

The best term for drones is actually RPA as it most clearly conveys what the technology is. The fact is that all current drones are remotely piloted by a human on the ground. RPA explains this concept better than any other term. Unfortunately, *RPA* is not commonly used, with only the United States Air Force referring to UAVs as such (Hoyle, 2013). While it may seem trivial, the name of a technology is how a person first interacts with it and the stigma of ‘drone’ or the confusion of ‘UAV’ leaves a poor first impression.

**The Physical Characteristics of RPAs**

While there are many forms of RPAs, they all share some common characteristics such as a primary sensor, a communication device, and an onboard controller. Additionally, many RPAs have other secondary sensors, and some even have control systems to make them more autonomous. These characteristics define what an RPA is and it is therefore important to understand them.

There are many sensors that an RPA may rely on to fly, and they are usually the most expensive, bulky, and important part of the RPA. The most common of these sensors is a camera. That being said, there are many different types of camera that an RPA may be outfitted with. The most common types are either normal or High Definition (HD) cameras that return an image similar to that of a human eye. These are widely used as most create a first-person perspective for flying. On many RPAs, these types of camera serve as a navigation tool. Many pre made RPAs for hobbyists use a GoPro™ Camera due to its low price and relative durability. These camera costs anywhere from $200 to $400, but are high definition (1080p), waterproof, lightweight, and Wi-Fi enabled, creating a clear line of communication with another device (GoPro, 2014). The Wi-Fi connection with a ground controller serves as a high-speed, high content exchange of data for RPAs that do not go too far away, usually limiting the operation range to 100 meters. While this is the most common high definition RPA camera, other cameras can cost anywhere from $100 to $500. The Sony 20.1MP, the camera onboard the Draganflyer X6, costs around $150 and is comparable to many professional cameras (Draganflyer, 2014).

Another type of camera uses thermal imaging which reads the different temperatures, creating a grayscale image. These devices can usually sense temperatures from -4°F to 3600°F (-

20°C to 2000°C) (Tyson, 2000). There are currently two types of thermal imaging cameras. The first and most common type is called *cooled thermal imaging* in which the sensor uses a cryocooler to keep the camera cold enough to operate. This will keep the image from collecting errors as the camera stays on and heats up, distorting the image. These cameras have a much higher definition and are usually considered to be of better quality. Unfortunately, this type needs moving parts, a gas chamber, and has a sensitivity to outside temperature changes. All these additional parts make the camera heavy and fragile, and quite unlikely to be chosen for RPA use.

The other type of thermal imaging, simply called *uncooled thermal imaging* does not have a cooling agent, but instead relies on the sensory data of a single thermal resistor. These cameras are less expensive, easier to manufacture, and have a higher service life as there are fewer parts to break down. With all of these factors, it seems odd that anyone would use cooled thermal imaging, but the lens changes this perspective. It turns out the lens for an uncooled thermal camera is a great deal more complicated, bulky, and expensive. This increases exponentially as the focal lens grows in length. Once the lens is large enough to be useful on RPAs, it becomes clear that these aircraft should use a cooled thermal camera despite its flaws (FLIR, 2014).

Another imaging technique used is Light Detection and Ranging, or LIDAR. This uses beams of light, or lasers, to create a three-dimensional map of the ground, creating a very accurate topographic map. This is comparable to how radar was used to find the ground for earlier aircraft, but LIDAR is significantly more accurate. Several satellites already utilize this sensor and a third of Afghanistan has been mapped in this way; the Navy hopes to use these sensors to help RPAs hunt for pirates (NOAA, 2014).

An additional type of camera worth mentioning is the ultrasonic sensor which is also used for imaging. Like LIDAR, these sensors also send out beams to map the world, but use sound instead of light. Admittedly, ultrasonic sensors are less accurate than their light-based competitor, but they are significantly cheaper and smaller. That is why ultrasonic sensors are the primary tool used for nonmilitary autonomous flight (Gross, 2013). The detail provided by these sensors is enough for some RPAs to automatically land as well as detect other objects such as buildings to avoid a collision. Commercially available ultrasonic sensors cost around $25, and can detect up to 16 feet (5m). Unfortunately, these units still weigh around 10 ounces (300g), more than half of the total payload for the Dragonflyer X6 (Draganflyer, 2014). Despite a high weight, these sensors are becoming more common on domestic RPAs as they expand beyond the traditional nose mounted HD camera.

The final and least commonly used camera uses hyperspectral imaging to detect objects better than a human eye. This is done by processing the electromagnetic signature of objects, allowing drones to easily differentiate between different materials and terrain. For example, the Air Force has used manned aircrafts outfitted with hyperspectral imaging to find illegal poppy fields and roadside bombs in Afghanistan. Police hope to use this technology to find unmarked graves from murders in addition to illegal plants (Weinberger, 2014)

Many military or professional RPAs utilize more than a single camera. The Gorgon Stare sensor system used nine cameras to watch over an entire city in Afghanistan. The next version, the Argus, used only four cameras but had a total of 368 focal points. Unfortunately, the camera definition means Argus was generating over 200 terabytes of data per hour (Weinberger, 2014). In a different use of multiple cameras, Raytheon and the US National Guard are using an RPA which integrates an infrared sensor, a color TV camera, and an image intensified TV camera to create a single overlaid image. This image has more detail and is more useful than what any of the sensors could produce on their own (Weinberger, 2014).

While they are the most common type, some RPAs utilize more than just camera sensors. The second most common sensor is a GPS, or global positioning system. Connected by satellite, this helps an RPA determine its position in a global frame. “GPS satellites circle the earth twice a day in a very precise orbit and transmit signal information to earth. GPS receivers take this information and use triangulation to calculate the user's exact location” (Garmin, 2014). While they have been improving since their integration in the 1980’s, GPSs are not known for their accuracy or precision.

> …a navigation system with only the GPS may give the unexpected data, especially when it is applied to a high dynamic UAV due to its low output rate. It will be unavailable when the number of satellites in view is less than 4… (Jiang, 2010)

This means that a GPS is inaccurate because of the low frequency of data acquisition caused by the long communication pause between the RPA and satellite. In addition to this problem, a GPS needs at least 4 satellites to function. Even when they do communicate, non-military GPS is accurate within 25 feet (7.8m) with 95% confidence (GPS.gov, 2014). Luckily, there are algorithms that help correct the GPS location by processing additional information such as speed and heading; some survey GPSs that can receive up to quarter-inch degree accuracy after post-processing (Trimble, 2013). This accuracy is not reflected when measuring altitude, which GPS is notoriously bad at; so despite the processing algorithms, it is quite illogical to solely rely on GPS for navigation which is why some RPAs use barometers.

Barometers are instruments that measure the pressure of the surrounding air and have traditionally been used for weather forecasting. However, these sensors also serve as an excellent indicator of altitude, as it can detect the change between the air pressure on the ground and while in the air. “Barometers can be and are effectively used to calculate altitude, once initialized and zeroed…. A barometer is a much more accurate and fast device to extract altitude, when operated correctly,” (Georacer, 2013). This claim by an RPA hobbyist was backed up by a test comparing the accuracy of a GPS to a $15 barometer in measuring altitude. After a test flight, only going 160 feet (50 meters) up in the air, the RPA was taken to the ground which the GPS claimed was a full 55 feet (~17m) higher than it had previously been. The barometer was accurate, with fluctuations less than an inch. For RPAs that require a higher degree of altitude accuracy, the clear answer is to use a barometer as it is small, cheap, lightweight, and reliable.

While sensors are important to an RPA’s flight, the information they collect would be useless without a clear line of communication to the ground controller. The earliest form of communication was a simple radio-controller with a pilot constantly at the controls (Howard, 2013). Newer lines of communication include: Bluetooth, satellite/microwave, and a wireless Internet connection. The type and size of the receiver can determine the range at which the RPA can communicate with the control module. The Predator drone actually has two lines of communication, using both the ground station’s dish for better control during takeoff and landing, and a satellite uplink for control when the RPA is far away. The satellite connection, although it offers a larger range of control, its connection speed is only 1.544 Megabits per second. The ground station dish, in comparison, offers a 4.5 Megabits per second connection, allowing three times the data transfer (Kingcope, 2013). Civilian satellites are even slower and much of their time is spent relaying GPS, phone calls, and television signals. It seems unlikely non-military RPAs will have a satellite connection. This leaves radio, Bluetooth, and wireless Internet as the civilian RPA‘s means of communication, but each has a very limited range which dearly restricts their usefulness. As the Internet’s range grows, more RPA flyers are hoping to wirelessly control their RPAs using cell towers. A great deal of reported RPA crashes occurred because the controller lost the connection long enough for the aircraft to fall out of the sky. Currently, companies are trying to increase the reliability and coverage of the Internet, such as Google which has unveiled Project Loon, high altitude balloons that provide Internet connectivity (Basulto, 2014). Internet based connections may be the most viable option in the future, but this invisible web is currently too unreliable and small to depend on as a sole means of control.

Now that RPAs have sensors and a communication line to the ground controller, the next item needed is an onboard controller. Many hobbyists use microcontrollers on the RPAs due to their small size, low power consumption, and the ease with which they are programmed.

> A microcontroller is a small and low-cost computer built for the purpose of dealing with specific tasks, such as displaying information in a microwave LED or receiving information from a television's remote control. Microcontrollers are mainly used in products that require a degree of control to be exerted by the user (EngineersGarage, 2010).

This means that a pilot can have the microcontroller send the sensor data to the ground controller for the more computationally heavy tasks. Microcontrollers have often been called incomplete computers. There are two types of microcontroller: preprogrammed and unprogrammed. Preprogrammed microcontrollers are generally more expensive, but require a significantly smaller amount of expertise. Unprogrammed controllers require someone who knows how to code, but allows for a greater amount of control. When a person is programming their own RPA, they can add or change the sensors on the aircraft. There are companies, such as the ones featured on the website DIYDrones, which help users build their own RPA, that are selling preprogrammed microcontrollers. This means that a pilot is required to do very little programming in order to fly his personal RPA. While these preprogrammed controllers limit the sensors a microcontroller can use, it means a greater number of people can access this technology.

The drawbacks for many microcontrollers are: the amount of information they can send and receive; the amount of data they can retain; and how much they can control. As the number and scope of the sensors increase, the computational power needed to send this data to the ground controller is also increased. The controller also increases with other factors such as security encryption and redundant systems. The Predator has both encrypted signals and a secondary computer on board in case the first one fails. As the computer systems become more complex, they also require additional space and power. This trade off means an RPA user must be very careful in selecting the onboard computer and what sensors to include.

While the characteristics of a RPA are relatively simple, there is quite a lot of variation, especially for sensors. Though there is no clear formula for what type of sensor, what communication device, and what microcontroller to include, this means many builders are creative in their design. This allow for many different RPAs to be built and flown, which ultimately means RPAs need to be classified.

**Classification**

While the physical characteristics of RPAs are well defined, the differences between RPAs and other technologies are not. For example as the technology grows, the boundary between satellite and RPA shrinks. Therefore, it is important to define this distinction in order to further understand RPAs.

Both RPAs and satellites are semiautonomous flying machines outfitted with sensors and communication devices. The two technologies often talk to each other, with many RPAs and satellites relying on other satellites to connect their signal to the ground controller. The main difference between a satellite and a RPA is the height at which the machine flies. People make the common mistake of thinking space is the differing altitude at which these two fly, but that is incorrect as some solar powered RPAs fly as high as 20 miles which constitutes low orbit (Constine & Perez, 2014). Satellites usually orbit anywhere from 150 to 450 miles, with some going as low as 111 miles and others go as high as 22,223 miles (Brown & Harris, 2000). Currently, the other distinguishing feature between RPAs and satellites is the image quality, with RPAs offering a much better image as they are both closer and easier to upgrade. This has caused several aerial imaging companies to abandon the commonly used satellite images in favor of the higher definition cameras, as well as the flexibility offered by the greater control of the RPA’s flight path (Gounari, 2012). This transfer of platform has been helped by the tight restrictions on satellite shutter-control placed there to “reduce threats to national security or foreign policy concern” (LaFleur, 2003). This means that the United States Government has the authority to remotely close the shutter on any American or allied satellite at any time despite ownership. As long as they remain outside of sensitive locations, such as army bases, the restrictions on RPA imaging are much more relaxed.

Now that they have been well defined, RPAs need to be classified in order to be well understood and used responsibly. As the United States militaries are the largest and most well-known users of RPAs, it is simply baffling that not a single branch can agree on what classification system to use. This is because the current systems are based on the few specific RPAs the armed forces are using instead of a sweeping classification. Take, for example, the United States Air force's use of a confusing multi-tiered system based on several parameters. Some of these classes only have a single RPA in them. Tier zero is based on the size of the RPA, including anything small enough to be carried by a single man. Tier I is based on the altitude, including anything with a 'low altitude'; there is no numerical definition for low. Tier II includes anything with a medium altitude, most notably the Predator drone and MQ-9 Reaper (US Air Force, 2010). To make matters worse, the next tier is called *Tier II+* which includes anything with a high altitude, but is still highly visible. Then Tier III- is defined as any stealth RPA that operates at a high altitude. The Air Force does not currently have any known RPAs operating under this tier since the production of the RQ-3 DarkStar was discontinued in 1996 (U.S. Air Force, 2014). So the Air force tier system is not only based on altitude, but also stealth capabilities and weight, creating an incomprehensible jumble of parameters.

The classification system used by the US Marines is much less confusing, with a four tier system based on size. Likewise, the Army has a system based on the operational range of the RPA. Until its cancellation in 2009, the Future Combat Systems (FCS) had a classification of 4 types varied by who would be using the RPA. The FAA has considered the option of creating a classification for domestic RPAs based on how many restriction would be placed on it, with three classes called 'standard', 'lightly restricted', and 'restricted' (Franchi, 2006). It seems unlikely that the FAA will pursue this system as there has already been a large backlash from those who would be ‘lightly restricted’, a class that includes agricultural RPAs as well as those owned by hobbyists (Franchi, 2006). In addition to the classifications mentioned, additional class systems proposed include: weight, a 5 designation system ranging from micro to super heavy; endurance and range, a three classed system with these two parameters; altitude, a system of three categories; classification based on wing load ability, the amount a RPA can lift divided by wing area; classification by engine type, primarily fan, electric, and piston; and finally a system based on use (Arjomandi, 2006). These classifications are shown in an appendix attached to this paper**.**

From the diverse systems being used, it is clear that there is not one classification that will suit everyone. Because of the gross differences in use and design, it makes sense that military and domestic classifications would be different; thus, there should be two systems. The military forces should utilize a system based on what the RPA is intended for, with categories such as: Intelligence, Surveillance, Target Acquisition, and Reconnaissance (ISTAR); Combat; Aerial Delivery and Resupply; Radar and Communication Relay; and finally Multi-Purpose. This is similar to the 2002 roadmap for classification based on mission capabilities which had an additional category for Vertical Takeoff and Landing (VTOL) however it does not make sense to give this its own class (Arjomandi, 2006). The technology and physical characteristics of RPAs are liable to change but their use will most likely not. The other characteristics such as size, range, and altitude will be implied by the categories of use. For example, a resupply RPA would be expected to have good wing load ability as well as a good range, size, and endurance. While there is a diverse group or RPAs that fit into ISTAR, varying from the X-63 Dragon-Eye that can fit in a backpack to the Boeing 757 sized Global Hawk, this category could be further broken down by size or wingspan.

Domestic RPAs, as stated above should be categorized differently. One of the large issues facing domestic RPA flight is the impact and possible danger it will expose to manned aircraft. The FAA has proposed separating the airspaces and manned craft usually fly above 500 feet (FAA Ground School, 2014). In addition, the IACP and several civilian groups are calling for warrants to be required for police flying under 400 feet. With these ideas in mind, it makes sense for domestic RPAs to be categorized based on altitude. This will help the FAA immediately recognize if an RPA would be a danger to manned aircraft and allow the public as well as the police to have a clear understanding of what is acceptable.

The current classification systems for RPAs are disorganized and confusing because they were constructed around the RPAs being built or used at that time. RPAs are changing and are going to continue to change, creating the need for a comprehensive system. This is why the military should classify RPAs based on their uses and the FAA should classify them based on their altitude.

**The Technical Issues with RPAs**

While they are constantly improving, RPAs are fraught with technical issues and errors. Fixing these errors has been slowed by the public's poor understanding of what RPAs are capable of and how to improve them. This is why one of the issues facing RPAs is how to educate the public. The most common problem pilots face while flying RPAs is connection complications. While a wireless computer mouse may lose connection with a computer for a second, the damage is minimal. With many small RPAs lacking basic safety functions, a short loss in connection can cause the RPA to fall out of the sky.

On October 3rd, 2013, amateur RPA pilot David Zablidowsky was arrested for reckless endangerment, as he had lost control of a small drone in Midtown Manhattan. He had, in fact very little control of the RPA, losing steering almost immediately after flying it off his balcony. Because the three pound drone had no safety features involved, the RPA immediately plummeted after his connection was severed, almost landing on a pedestrian in Central Park (Hoffer, 2013). The RPA, fortunately did not hurt anyone, and only caused minimal damage to the building it collided with, but improper use can hurt people.

In Virginia, journalist students at the University of Missouri attempted to capture the Bull Run from the sky by using an RPA. The Bull Run, in which bulls chase athletes in a test of speed, actually caused fewer injuries than the RPA did when it fell into the crowd of spectators. Four to five people were injured and the University of Missouri was ordered to shut down its drone journalism program (Fung, 2013).

The RPA crashes are not limited to the United States, as an RPA collided with the Sydney harbor bridge in Australia and ended up landing in front of a train, forcing it to stop. The train operator reported, “It’s an odd looking plane, it’s got a red light flashing, I don’t know whether it’s a bomb or not” (Lee, 2013). The small RPA shut down the bridge; and a counter terrorism investigation was launched before the pilot came forward, explaining he was testing the RPA before using it to record a concert.

These crashes are more common with small hobbyist-built RPAs simply because of the machines are simpler and cheaper, but military RPAs crash was well. A 375 pound, eleven foot long military RPA crashed near a Pennsylvanian elementary school in April of 2014 (RT, 2014). The military is currently unsure of what caused the crash and is not releasing details, but it is clear the pilots had very little control where the RQ-7 Shadow RPA landed. This event is similar to the US border patrol’s two well publicized crashes. Earlier in 2014, the Border Patrol had to land one of their Predator-B RPAs in the Pacific Ocean, after a mechanical failure rendered it un-landable. This was not the agency’s first lost, as operating crew errors caused a crash in 2006 (Carroll, 2014).

From these examples, it is easy to see RPAs crash for a variety of reasons. The first and most prevalent reason is a loss of contact with the ground controller, which usually leads to the RPA simply falling out of the sky. The reliability of these connections is not likely to change for many hobbyists any time soon as civilian data connections are notoriously temperamental. Fortunately, there is a relatively easy fix for this issue: making RPAs more autonomous.

While the sensor, communication device, and controller are the basic pieces needed for RPAs, many of these aircrafts also include systems that provide varying degrees of autonomy. For example, the company 3D Robotics sells a variety of preprogrammed autopilot controllers that allow a pilot to do anything from set waypoints, to automatically land, to conduct a fully autonomous flight. These computer chips usually cost $200-$300, but allow the pilot to have much finer control (3DRobotics, 2014). Arduino, a well-known microcontroller manufacturer, sells a programmable UAV controller for only $25. It is important to note that these functions require more precise sensors than the traditional camera. In order to autoland, an RPA needs an excellent understanding of exactly where the ground is at all times. This is why many of these systems require an ultrasonic sensor in order to land and a barometer to find the waypoints.

Because these autopilot modules and programs exist, it is possible to include automatic safety features. Members of the FAA, the Federal Aviation Administration, want to require RPAs to have an automatic avoidance system so they would not hit other aircraft (Kenyon, 2012). While this may seem to be a simple step from implementing automatic landings, this is much more difficult to implement as it requires communication with another aircraft. This would mean all aircraft would have to be outfitted with an electronic signal, a time intensive and costly process.

The other alternative is to implement a Ground Based Sense and Avoid System (GBSAA) for all aircraft. This would require all aircraft to have an additional transmitter for their location. The director of the Air Force Research Lab (ARL), Joe Sciabica, claimed that the GBSAA was necessary to make RPAs as aware as manned aircraft (Kenyon, 2012). With 137 recorded crashes of manned aircraft in 2013 alone, RPAs will hopefully have better spatial awareness than their counterparts (B3A, 2014). While there would be many advantages to implementing a GBSAA, mostly safety, this system does not make sense for all aircraft. For example: the Parrot's line of quadcopters cannot fly over 100m high and require a constant human controller (Parrot, 2014). It does not make sense to make these lightweight machines require an additional transmitter for the GBSAA system to work. It would be more logical to require RPAs capable of achieving a certain altitude to be integrated into the GBSAA. Some aircraft, such as the Predator, already have detect-and-avoid systems implanted, but it is irrational to require this on very low altitude machines.

Another safety feature RPAs could implement is a low battery, or lost connection automatic land. This can be done with varying degrees of difficulty; the simplest solution is to create a system that detects loss of connection or low battery and decrease motor speed, allowing for a slow descent. Unfortunately, this simple setup does not factor in wind, rough terrain, or initial speeds. For example, if the RPA had originally been moving sideways before the automatic system took over, or being blown by the wind, the RPA could end up very far away. The terrain could be rough enough that the RPA cannot land without damaging itself or the RPA could be over water. Fortunately, automatic landings can be improved with additional sensors, and even rough landings are better than falling out of the sky. Therefore, for the safety of the RPA and the people around it, RPAs should be required to have an automatic landing function.

An even simpler safety feature would be to simply hover the RPA when a connection is lost. This will stop RPAs from falling onto people and is relatively easy to implement, especially for rotary wing RPAs. While will still be subject to strong winds and low battery, this system in relatively simple to implement on almost any RPA. There is no reason not to require this feature for RPAs flown in populated areas.

As RPAs become more popular and complex, they become an additional computer system at threat from hackers. Take, for example, the writer of the zombie drone software, Sammy Kamkar, whose software uses a Parrot RPA to find and take over other wireless internet controlled RPAs. Using a small computer, the program finds and overrides other RPAs by overpowering and mimicking the ground controller’s signal. This software is currently available online, useful to anyone with a Linux based Operating System (Kamkar, 2013).

There is a clear response to combat hacking, but this solution offers many drawbacks. In order to fight hackers, data signals need to be encrypted, meaning each RPA will only respond to a ground controller that gives it the correct ‘password’, or encryption key. The Predator RPA, for example, uses an unique 16 byte code; that means there are 2^128 (over 340 undecillion) possible combinations, unbreakable by current technological constraints (Kingcope, 2009). While non-military RPAs will not need such an extensive encryption key, any encryption will create a larger data stream, slowing down the communication between the controller and the ground. Encryption also has limitations, meaning that while it stops an RPA from being controlled by an outside source, it does not stop the signal from being overpowered. The RPA may ignore new instructions from the hacker, but the real ground controller can be stopped from getting a signal to the RPA. While encrypting the control signal has many faults, it is the only solution to combat hacking.

Now that the issues of autonomy and hacking have been addressed, the matter of public education should ensue. As previously mentioned, the average American views RPAs as the machines used for fighting terrorist, a machine taken out of a science fiction novel. This means that many people are unclear of how autonomous RPAs actually are. While some RPAs have auto land and waypoint navigation, the vast majority rely on a constant human pilot. Even those with semi-autonomous systems require a human to look out for unexpected conditions such as other aircraft.

There are simple fixes for many RPA issues and little reason not to implement them. As the technology improves, these issues may disappear but RPAs need to become safer as they enter the public’s focus.

## Educating the Public

One important issue the public needs to be educated about is the ease at which the average person can obtain or build an RPA. Online resources can help a person build a RPA and many companies sell finished versions. There are support communities and meet up where hobbyists learn the best ways to build and pilot an RPA from each other. And while Predator drones cost millions of dollars to build and operate, RPAs can be bought for only $100. There is a broad horizon of what an RPA is capable of, only limited by what a person is willing to spend.

There are inherent problems that arise when a new technology becomes widespread and RPAs are no different. Without proper guidelines and legislation, these aircraft can be used for spying, criminal activity, or as a lethal weapon by the incorrect parties.

The public should also be aware of the fact that RPAs are useful for more than just assassination, the only use commonly shown in the media. RPAs are simply another technology, one that can greatly benefit the economy and, therefore, everyone. As explained later in this paper, the introduction of RPAs will create a market that generates $10 billion of revenue each year (Jenkins & Vasigh, 2013). RPAs will also help a great many companies save money, as they will replace costly procedures. For example, geological surveys will be much cheaper to complete with an RPA than the current alternative, a helicopter. Power line inspection, a costly and dangerous profession will be done cheaply and safely by an RPA.

This is the best way to get the American public to embrace the use of RPAs. According to an economics report by the Association for Unmanned Vehicle Systems International (AUVSI), RPA integration will create 70,000 new jobs between 2015 and 2018, with 103,776 jobs by 2025 (AUVSI, 2013). The American people respond well to technologies that stimulate the economy, and RPAs certainly will. Therefore, the best way to change public perception on RPAs is to show their value, a necessary step as RPAs continue to become a larger part of the modern world.

**The Future of RPAs**

While there is a lot of speculation into the future of RPAs, it is difficult to determine what the future designs will be like. Innovation is rarely a straight line, but there are some innovations that are dearly needed and can thus be predicted. Right now, one the chief limiting factors for RPAs is the battery life. Many hobbyist or domestic RPAs can only fly for less than an hour with the current battery technology. Though the Predator drone can fly for 48 hours, this is because the on board battery is quite large and heavy, a solution not offered to smaller RPAs. While computers and sensors have continued to shrink in size and grow in complexity, batteries have remained largely unchanged in recent history. Rechargeable battery devices all use the same lithium-ion polymer battery released in 1997 with little change to chemical computation and design (Moore, 2008). The worrying trend is clearly apparent in cell phones, which have been plagued by a lower battery life as the complexity of the cell phone grows. While some companies have invested in lower power electrical systems, this is an expensive fix to a much larger problem. There is a clear and present need for an improved battery.

Several solutions to the battery issue have been proposed and some are still in the testing phase, showing great promise. The first innovation in battery technology is the creation of a sodium-ion battery, which can store more energy than their lithium-ion counterpart. Because sodium is more abundant and cheaper to manufacture than lithium, these new batteries would be cheaper as well. And while they are still in the testing phase, the media has exploded with claims that this new battery type would revolutionize battery life. In fact, the US Department of Energy has invested hundreds of millions of dollars into the development and testing of these batteries (DoE, 2012). While it is a clear improvement in every regard, sodium-ion batteries have been shown to only hold 30% more charge than the current models (Noorden, 2014). So while this is a much needed advancement, this is not the revolution battery technology sorely needs, at least not by itself.

The next type of battery innovation to catch the public's attention is the use carbon nanotubes in the battery's coating. A Carbon Nanotube is a tube-shaped material, made of carbon, having a diameter measuring on the nanometer scale. A nanometer is one-billionth of a meter, or about one ten-thousandth of the thickness of a human hair (Nanocly, 2008). These tiny forests allow current lithium ion batteries to charge in seconds rather than hours and allow the formerly rigid body to be flexible enough to bend. Because the nanotubes allow for a better connection, conventional batteries would be able to hold an additional third of its charge and output power ten times what it previously could (Dixon, 2010). While it is still early in its testing, carbon nanotubes will make a clear impact on battery technology, especially if they are used in conjunction with sodium-ion batteries.

Finally, a German battery firm called *DBM Energy* claimed it had a new wonder battery in 2010. According to an unofficial road-test, this new battery held enough power in a single charge to drive an Audi Az Electric Car 375 miles at 55 mph (Gordon-Bloomfield, 2010). While other companies have claimed higher distances, their batteries were much larger and this battery currently has the highest energy density, the most power per mass. This was not their only claim, as the company went on to state that the battery could fully charge within 6 minutes. Unfortunately, there are many questions about the validity of these claims.

> The company has been a slippery eel on validation. DBM Energy's battery work is supported by the German economics ministry (with $370,000 in funding) but before any official testing on the miracle pack could be done…disaster struck. In December 2010, the car that had reportedly made that history-making run burned up mysteriously in a warehouse fire. A dog ate the homework, in other words. (Motavalli, 2012)

The company has offered very little in the way of scientific evidence, claiming they are doing so in order to protect their privacy. While a new wonder battery for electric cars would be amazing, and would quickly transition to aircraft, it seems like this claim was false. While journalists and government officials continue to argue over the validity of these claims, it is clear better battery technology is utterly essential.

While these battery innovations are still in the testing phase, they can make a clear difference in RPA technology. Because RPAs have a very limited payload weight, it is important to get a battery with a high energy density and high power output. The majority of onboard weight is the battery which is always denser and usually larger than the electrical systems.

In addition to changing the batteries, the physical body of RPAs is liable to change soon as well. This is because RPAs, especially the fixed wing variety, are based on traditional aircraft design. Traditional aircrafts are limited by what the human body can comfortably experience. For example, the average human can only withstand 5G's of force, or five times the gravitational force of the earth, before passing out (Tyson, 2007). With the use a of a special flight suit and training, individuals can withstand a force around 9G's before a lack of blood flow renders them unconscious. While a person can survive a higher force before dying, aircraft are not designed to render their passengers unconscious. The world record for highest g-force survived belongs to a race car driver who survived a 214G crash (Slade, 2009). When this is compared to what the average mechanical wrist watch can survive (over 5,000G's), it becomes clear that humans are the limiting factor for aircraft speed and maneuverability. Because RPAs do not need to be concerned with an onboard human, they are able to achieve much higher speeds, tighter turns, and other finer motions. Despite this well understood fact, many RPAs are based on traditional aircraft. For example, the well-known Predator houses its computer systems where the human pilot would traditionally sit simply because the designers thought the computer was taking the place of the pilot (Whittle, 2013). It would only make sense that they would sit in the same spot.

It is clear that as they become more widespread, RPAs will look less like traditional aircrafts and be designed without the constraints of a human pilot. For example, the Phantom Sentinel, a military RPA, is said to constantly spin to maintain a 360° line of sight (Stafford, 2009). While the Phantom is currently unique, more spinning RPAs may be designed as time goes on.

There is currently one major difference between manned crafts and RPAs in terms of design. While traditional aircraft are built to keep a person alive and comfortable, RPAs were always created with weight constraints in mind. Because flying with sensors can be more difficult than with a human pilot, the past method has been to cram as many sensors as possible onto an aircraft. This has left RPA designers scrambling to create the most lightweight frame possible in order to maximize carry weight. Smaller RPAs have been described as “lightweight and flimsy”. Larger RPAs, especially those used by the military, are usually more hardy because of the situations they may find themselves in. That being said, these RPAs are considered bulky and unyielding. As stated by an RPA engineer at MIT, “Trying to find a way for vehicles to dog fight will be interesting but could potentially be done” (Ryan, 2014). The physical characteristics should and will change as RPAs become more common.

The final predictable change that will occur as RPAs become widespread is the new laws that will arise. As RPAs are a relatively new technology, especially outside of the military, many laws are not currently in place. As RPA use grows, laws will have to be implemented to keep people safe as well as respect privacy. In the United States of America, there are currently no requirements for RPA pilots, meaning anyone, no matter how untrained, may pilot these devices. This is a clear and present danger and correct action must be taken.

## Conclusion

RPAs are a diverse group of machines that span from the very large to the unbelievably minute. Despite a wide range of styles and uses, RPAs have been poorly understood and suffer a worse reputation because of this. The first step to fixing this issue is to rebrand drones and UAVs as RPAs, as this acronym is a better description of this technology. RPAs should also have universal classification systems, as there is a wide variation of styles and uses. The new classification systems should be based on maximum altitude and range for domestic RPAs, and what their use is for military RPAs. The sensors, controller and communication devices, are what classify an aircraft as an RPA even though there is a wide range in each of these parts. As mentioned earlier, one of the main issues in regard to RPAs is how to educate the public which can be solved by the successful integration of RPAs into the economy. The other issue of connectivity loss can be fixed by adding autonomous systems that allow RPAs to safely land of hover. While there is no current solution to poor battery life, several innovations in this field may create a notable impact soon. In regard to the future, less traditional RPA designs will become more widespread as designers realize that they are no longer constrained by an onboard human. The future of RPAs is bright and diverse, but only if they can successfully be implemented domestically.

## Domestic RPA Use

### The FAA

February 14, 2012 was the day that the "FAA Modernization and Reform Act (FMRA) of 2012 (H.R. 658) [was] signed into law by President Obama" (DACR). This three hundred page law written to "amend title 49, United States Code, to authorize appropriations for the Federal Aviation Administration . . . to streamline programs, create efficiencies, reduce waste, and improve aviation safety and capacity" (H.R.658), is known by most Americans for only five pages. These pages "tasked the Federal Aviation Administration (FAA) with integrating [RPAs] . . . by September 2015" (Dolan & Thomson II, 2013, p.1).

These five pages gave the FAA an extensive list of goals. FMRA contained a number of details about the specific goals the FAA was supposed to achieve and listed deadlines for each particular goal. In total FMRA listed out seventeen goals to be accomplished before the calendar end of 2015 (Dillingham, 2013). The goals are tied together; each one is unable to meet its own deadline without the other meeting it's first. This is why out of the eighteen goals there are only eleven deadlines that the FAA is mandated to meet by FMRA. At the moment the FAA is in the middle of implementing FMRA, since five of the deadlines are passed and nine of the goals have been achieved (Scovel III, 2014).

The first deadline mandated by FMRA was for May of 2012, 90 days after the enactment of FMRA (Subtitle B-Unmanned Aircraft Systems, 2012). This particular portion of the law had two parts that needed to happen simultaneously. The first part was to build on what the FAA had already accomplished with the Certificates of Authorization (COAs).The FAA had to build off of work they had already done over the years regarding RPAs. Overall, the goal was to simplify the process of issuing Certificates of Authorization (COAs) for public use of RPAs (Scovel III, 2014). The FAA had already created a specialized process for public entities, like non-profit universities and government agencies, to acquire COAs and had in fact already issued large numbers of these COAs since 2007 (Federal Aviation Administration, 2013). To meet this requirement the FAA changed the length of the COAs to twenty-four months, doubling the original lifespan ("FAA Makes Progress," 2012). This was supposed to be a first step to speeding up the process, one that the FAA could further at a later date. This was the only part of FMRA regarding RPAs that the FAA was able to achieve on time, but this was partially due to having started the process back in 2009 before being mandated by passage of FMRA ("FAA Makes Progress," 2012).

While the first part of FMRA's first deadline required a general acceleration of the COAs, the second part of the initial deadline required the FAA to work with other departments of the government to make the processing of COAs easier between agencies. The law required the FAA to work with other agencies to create special agreements that would lessen the burden of having to file COAs for government agencies. The FAA set up Memorandums of Understanding (MOU) and Memorandums of Agreement (MOA) with "the DoD [Department of Defense], the Department of Homeland Security (DHS), the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), the Department of Justice (DOJ) and other public entities" (FAA Roadmap, year). These MOUs were also supposed to help the FAA gather more information from agencies that were already using RPAs extensively, like the DoD. These agreements were mandated to be done by May of 2012, yet the FAA did not have "a streamlined COA process via MOUs" (Scovel III, 2014) until March 2013. While accelerating other agencies' use of RPAs with MOUs was completed far behind schedule, the MOUs have still not allowed the FAA to get all of the useful information from agencies such as the DoD (Scovel III, 2014). This information includes a variety of issues, like maintenance requirements for example.

The second deadline FMRA established was August of 2012, seven months after enactment (FMRA). This particular deadline was one of the larger ones for the FAA, as it required three goals with distinct differences. The primary goal was first to "[d]etermine if certain UAS may operate safely in the National Airspace System (NAS) before completion of the Comprehensive Plan and rulemaking" (Scovel III, 2014). This initial determination was needed to allow the FAA to gather further data about RPAs to aid them when they started writing the Comprehensive Plan for rules regarding RPAs. The FAA decided they could allow RPAs to operate within the NAS, and "issued restricted category type certificates" (Giant Leap) to two separate RPAs. They limited these certificates of use within certain Arctic areas as part of their plan to "[establish] three permanent Arctic areas to comply with [FMRA]" (Arctic Plan). These areas are called Arctic more for the conditions than location, which has been in areas off the coast of Alaska like the Bering Strait where RPAs have been allowed for search and rescue. This was an attempt to accomplish two of the goals simultaneously, however instead of speeding up the process, the Arctic plan was not signed until the November of 2012 and the special certificates were not issued until July of 2013. So the FAA ended up missing both of the deadlines instead of accomplishing them faster by attempting them simultaneously.

The FAA was also required to establish a program with six test sites to gather additional data about integrating RPAs into the NAS before August 2012 (Scovel III, 2014). However, while FMRA required the six test sites, it was silent about the "FAA's legal authority to establish privacy protections when it engages in rulemaking" (Dolan & Thomson II, 2013). As the

Congressional Research Service noted during its review of several legal issues regarding RPAs there are two main viewpoints on the FAA's true authority. The two points are largely based on the interpretation of FMRA. One interpretation was that privacy was covered by the word *comprehensive* in the mandate to create the UAS Comprehensive Plan. The other argument is that since Congress did not list privacy as one of the FAA's task, they then did not give the FAA the power to do so. Regardless, this became a large portion of the issues brought before the FAA during its open comment period on the Unmanned Aircraft Test Site Program. In an attempt to avoid the issue, the FAA initially made it clear that its "mission is to provide the safest, most efficient aerospace system in the world and does not include regulation [of] privacy" (FAA Response to Comments). Despite this, after a large amount of feedback from the public, the FAA decided to try and reduce privacy concerns before moving forward with the test sites. In setting up the six test sites and addressing the privacy concerns given during the open comment period, "the internal review process of the Screening Information Request was delayed" (Dillingham, 2013). Since the Screening Information Request was needed "to initiate the competitive bid process for selecting the six test ranges" (Dillingham, 2013), choosing the test sites was also delayed. The FAA "hired a privacy expert to help develop a strategy to address these concerns" (Dillingham, 2013), but were still not able to meet FMRA's deadline. Given that the "FAA has had difficulty working across lines of business in the past" (Scovel III, 2014), it is of little wonder that the test site integration was not completed until December 30th 2013, a full year after FMRA mandated. These test sites were intended to have special agreements with the FAA called Other Transaction Agreements (OTAs), which were designed to allow RPA operation at the site and share the data with the FAA. This data was important for the FAA because it was to be combined with the data from the MOUs and Arctic sites, to help guide the FAAs decisions regarding the Comprehensive Plan and Roadmap.

Since the three Arctic sites and the six test ranges were both over a year late and the MOUs were still not allowing free flow of information between all agencies, the third deadline of November 2012 was inevitably missed as well. November was the deadline for the FAA to develop the Comprehensive Plan that would outline the integration process of RPAs into the NAS, and issue additional guidance on the operation of RPAs by government and non-profit organizations to further speed up RPA approval processes (Scovel III, 2014).

Since the FAA had already doubled how long COAs lasted, back in May 2012, they took steps to actually expedite the processing time. Two months after the original deadline, the FAA issued Notice 8900.207 to outline the "policies necessary for reviewing and evaluation of the safety and interoperability of proposed [RPA] flight operations conducted within the United States [NAS] . . . when assessing applications for a [COA] or special airworthiness certificate" (AFS-80, 2013). This notice was created with input from government agencies, industry, and users based on prior COA and special airworthiness certificate applications (AFS-80, 2013). The document gave detailed guidelines on what COA applicants were expected to provide to the FAA and what the operating procedures for COA holders would be. It also helped synchronize the three different branches of the FAA responsible for different parts of the COA process. This was not a Comprehensive Plan or final ruling, but more of a consensus of the collected laws and rules that were applicable to RPAs.

Creating a Comprehensive Plan was a separate task that was supposed to happen by the same deadline as expediting the RPA approval process. The Comprehensive Plan was designed by FMRA to detail what steps were needed to achieve safe integration of RPAs into the NAS by other future deadlines. The plan was to be created with input from representatives of several different areas, specifically: aviation industry, federal agencies that use RPAs, and RPA industry (FRMA, 2012). Instead the Joint Planning and Development Office (JPDO), under guidance from the NextGen Senior Policy Committee (SPC), "[assembled] executive-and working level teams comprised of individuals from the NextGen partner agencies - the Department of Transportation (DOT), Defense (DoD), Commerce (DOC), and Homeland Security (DHS) as well as the National Aeronautics and Space Administration (NASA), and the Federal Aviation Administration (FAA)" (Joint Planning and Development Office, 2013), to create this plan. The FFA left out some agencies that use RPAs, like the Department of Justice (DOJ), who would have had more insight about some of the privacy issues that have plagued other deadlines. Instead the Comprehensive Plan reiterates that the FAA's "chief mission is to ensure the safety and efficiency of the NAS" (Joint Planning and Development Office, 2013).

Despite leaving out some agencies and ignoring the issue of privacy again, the FAA was still unable to meet its next deadline of February 2013, which required it to submit the Comprehensive Plan to Congress, develop a five year roadmap for the introduction of RPAs into the NAS, and make one of the six test sites operational. The first requirement for this deadline, the Comprehensive Plan, was not submitted until November after getting entangled in an interagency review process. November also happened to be the month the FAA finished its Roadmap, also after substantial revisions. As far as making one of the test sites operational by February 2013, actually picking the test sites out was not completed until December 2013. Even once the sites were decided the FAA has admitted that it will still take another six months to make one operational, which should hopefully be July of 2013. Making the test sites operational should be one of the goals the FAA can achieve somewhat more easily, especially given that in some cases millions of dollars were put upfront to help secure and build test sites like the one in North Dakota (B. Milavetz, personal communication, March 12, 2014). Getting a test site operational is highly important because as Associate Vice President of Research, Development, and Compliance Committee Barry Milavetz notes, “the longer it takes to get started the less time the designation to be a test site will have any significance” (personal communication, March 12, 2014).

The rest of the remaining deadlines for the FAA are set in the future and are still only plans. However, the Final Rule on small UAVs (sUAVs) required by August 2014 has been stated by FAA officials as unachievable (Scovel III, 2014). This is arguably one of the largest goals for the FAA, as Doctor Jerry LeMieux the President at Unmanned Vehicle University said “you are going to see thousands of companies start up as soon as that rule passes” (personal communication, February 27, 2014)

One of the major issues that have slowed the FAA down on meeting its goals has been the simultaneous Next Generation Air Transportation System (NextGen) project. While FMRA is most notably known for mandating the RPA integration into the NAS, the majority of mandates from FMRA are regarding NextGen. The FAA has high expectations for NextGen to be “a series of inter-linked programs, systems, and policies that implement advanced technologies and capabilities to dramatically change the way the current aviation system is operated” (Federal Aviation Administration, 2011). This large goal is the FAA’s primary focus, which is why they have tried to “incorporate [the] UAS plan into [the] overall NextGen Implementation Plan” (LaCour & Wilson, 2013). The FAA hopes to not only use NextGen in America, but to eventually expand to the global aviation system as a whole (Federal Aviation Administration, 2011). A large part of the NextGen plan is to “Transition from analog voice communications to predominantly digital communications” (LaCour & Wilson, 2013); this would play a large role in integrating RPAs into the NAS. The multitudes of technologies that are involved in the NextGen plan are actually needed for full RPA integration. The NextGen project, however, has not been immune from significant delays. For instance the technology for ADS-B *In*, which is “the foundation for shifting from today’s ground-based radar to NextGen’s satellite-based systems” (Scovel III, 2013), is still evolving and difficult for the FAA to begin making technical requirements, needed by 2020.

FMRA required the FAA to accomplish a lot of things at once, implementing the NextGen system while integrating RPAs into the NAS has been fraught with difficulties and setbacks. The FAA has met few deadlines and has tried to ignore issues like privacy instead of dealing with them or handing them over to another agency. The FAA is likely to continue on this path, given that they have announced few changes. The biggest question left about the FAA’s progress is how far it will actually put the RPA industry in America behind the rest of the world.

**Pirker**

While the FAA has been pressured to accelerate its rulemaking for RPAs by many parties, including Congress through the use of FMRA, it has tried to maintain control of RPA use in the NAS. Primarily, the FAA has relied on a notice of policy from 2007. This notice attempts to set specific categories for how RPAs can and cannot be operated. Under the notice's policy statement the FAA says that "no person may operate a [RPA] in the [NAS] without specific authority" (Sabatini, 2007, p. 5). The FAA clarifies that this authority can only come from one of three FAA documents. Public RPAs, those operated by the government or non-profit organizations like universities, were only allowed to use COAs. Civil RPAs, or any RPA that was used for profit, were required to obtain special airworthiness certificates, This notice was announced in 2007, six years before the first certificates for commercial use were issued. Private individuals, on the other hand, could operate under Advisory Circular 91-57 according to the 2007 announcement by the FAA (Sabatini, 2007).

The FAA has had several complaints about this ruling, not only because of its implications, but because of the way it was implemented. The FAA follows the United States Code, which outlines how agencies make rules. The specific guidelines leave some options, but all of the options require an agency to gather some public feedback before implementing any restriction. Since the FAA did not go through the process of proposing the rule and receiving feedback from the public, with a minimum 30 days before being effective (5 U.S. Code Section 553 - Rule making, 2014), the rule can only stand by using an exception. There are only two exceptions to this process. The first is in cases where an agency has a "good cause" that following this open to the public procedure is "impracticable, unnecessary, or contrary to the public interest” (Aeronautics and Space, 2014, p.24). The other exception that an agency can use to bypass any form of public rulemaking process is by interpreting rules already in place.

This attempt by the FAA to establish a rule that could control RPA use has been highly controversial especially with private commercial operators. The FAA has attempted to use 'cease and desist' letters as well as fines, based on this rule, to individuals who have operated RPAs commercially. In one of these cases the individual named Raphael Pirker filed a motion to dismiss. Pirker challenged the FAA on multiple points and was able to get the case dismissed. While the FAA has announced plans to appeal the decision, the arguments Pirker used in his motion are important to understand. As they deal directly with the two exceptions and these arguments could be filed by more people invested in using RPAs for commercial purposes, until the FAA finishes the integration process.

The first point Pirker made against the FAA was their failure to interpret any current laws or rulings. The FAA claim in the 2007 notice that Advisory Circular 91-57 only applies to model RC aircraft operating for recreational use, and not for profit (Sabatini, 2007). This is clearly a faulty interpretation since Advisory Circular 91-57 only “encourages voluntary compliance” (Federal Aviation Administration, 1981, p.1). The advisory has no actual power behind it and only offers guidelines for operating remote control aircraft, making no mention of reasons or business. As Pirker mentions in his case there have in fact been many cases since the advisory of individuals using RC aircraft for profit.

One of the issues with the 2007 Notice of Policy, is in the word *policy*. By calling this a *notice of policy*, the FAA actually may make this notice non-binding. A statement of policy is considered by the Court simply an announcement of what an agency hopes to implement in the future, and cannot be relied upon as actual law (*Pacific Gas & Electric Co. v. Federal Power*

*Commission*, 1974). This implies, based on the name, that the FAA gave no authority with this notice.

The FAA did, however, try to enforce the notice even if they declared it like a policy announcement. The FAA cites several other documents in the 2007 Notice that state where authority to operate comes from, for each type of craft. For RPAs the Notice declares that the authority to operate an RPA comes from a COA (Sabatini, 2007). The FAA does not actually cite any previous rule to explain why RPAs need a COA to operate. This is a key issue regarding the Notice, because “for purposes of the APA exception to notice-and-comment rulemaking, it must actually interpret a provision in an existing statute or regulation” (*Federal Aviation Administration v. Raphael Pirker*, 2013, p.25). Previous courts have ruled stating that “where an agency’s statement does not purport to interpret a statute or regulation, it is not an interpretative rule” (*Brown Express Inc. v. U.S.*, 1979). Without any mention of a previous rule or any type of explanation, the FAA simply cannot use the APA exception of interpretation.

The FAA has only one other option to use as an exception to the APA rulemaking process. This other exception is when the FAA has “good cause,” for example “in response to a safety emergency” (Aeronautics and Space, 2014, p.24). Clearly there is no emergency or sudden use of RPAs since they have existed for several decades.

These issues with the process the FAA has used to slow RPA operations have already won in Court against the FAA. Very little has been put out in the way of counter arguments or defense, and there has yet to be an expansion to the 2007 Notice or offer of any actual explanation. This is viewed by many as an attempt to try and delay integration until a controlled, regulated process can be implemented. Due to the long list of missed deadlines this tactic is likely to become less workable, especially as cases like Pirker’s win in Court against the FAA.

Pirker's case adds extra pressure to the FAA and highlights the frustrations the RPA industry has over the FAA's handling of the current mandates.

The FAA has failed to meet almost every deadline mandated by FMRA. The FAA has not moved quickly to implement many adjectives, and still has many more to go. Integrating RPAs into the NAS at the same time as overhauling the entire aviation system through the NextGen project has definitely slowed the process down even further. Privacy issues have also derailed the FAA, which is incapable and unwilling to handle the issue. Despite all of this it is important to remember the FAA's performance in minimizing aircraft crashes, which has been extraordinary. This performance will not be maintained if RPAs start flying without any guidance. The FAA has tried to buy some time by banning all RPA flights, but this method has started to fail. Pirker has broken the FAA's all inclusive ban; this puts a large amount of pressure on the FAA. Since they will not be able to maintain a total ban, the regulations will be needed much sooner than the FAA was likely originally planning.

**Safety**

Safety is the FAA's largest concern about RPA and a primary reason for their blanket ban. They have repeatedly stated that their goal "is to develop regulations, policy, procedures, guidance material, and training requirements to support safe and efficient [RPA] operation in the NAS" (Federal Aviation Administration & UAS Aviation Rulemaking Committee, 2013). This is the main area of experience and expertise for the FAA one that the FAA feels most confident in handling. The FAA has tried to maintain the status quo by limiting RPA flights in the NAS until they can implement their own regulations.

One of the first steps the FAA has taken to make RPAs safe is to prepare for full NAS integration, as opposed to a partial integration. The difference between full and partial is specifically about airspace classifications. As Jim Poss said during an interview "you have got to be prepared to have [RPAs] fully integrated" (personal communication, March 13, 2014). This means RPAs will not have a separate class of airspace apart from regular manned aircraft. The FAA prefers to set the standards so that RPAs can mix with manned aircraft, even if they are unlikely to actually mix. Some debate is still going over how these requirements will affect smaller RPAs that would stay below 400 feet. As Jerry LeMieux stated "[those requirements] will make the vehicle unaffordable," specifically referring to smaller RPAs that remained below the minimum altitude for manned aircraft (personal communication, February 27, 2014).

The requirements for flying RPAs with manned aircraft are a sense and avoid system for RPAs. The FAA is still researching the technology needed to detect and avoid other aircraft, and admit that "solutions may not be feasible until the long-term" (Federal Aviation Administration; UAS Aviation Rulemaking Committee, 2013, p. 34). *Long-term* is the term the FAA uses to describe anything more than a decade away. This time frame is likely to stay on track since the FAA is still researching "performance levels" for sense and avoid technologies (Federal Aviation Administration; UAS Aviation Rulemaking Committee, 2013). The FAA is particularly interested in using Airborne Sense and Avoid (ABSAA) in the long term, while using Ground Based Sense and Avoid (GBSAA) in the short term for localized integration (Federal Aviation Administration & UAS Aviation Rulemaking Committee, 2013). This is one of the largest issues for mass integration, but could potentially be sidestepped for small RPAs that have maximum operating altitudes that are below minimum operating altitudes for regular aircraft. This could allow commercial applications of RPAs for many sectors, while allowing the FAA time to further develop technology necessary for full integration.

The FAA also considers control and communication a primary goal. This is a large concern, because it is an unfamiliar field given that manned aircraft do not require constant communication with anything or anyone. RPAs further complicate the issue due to their use of multiple communication paths. As noted before RPAs can communicate using various systems, like radio or satellite. Some of these communication methods could be further complicated as they fall under the realm of other government agencies. For example, the Federal Communications Commission (FCC) is in charge of all non-federal use of radio signals (Federal Aviation Administration; UAS Aviation Rulemaking Committee, 2013). This would require the FCC and FAA to work together in order for RPAs to use radio signals to navigate. Since this would only cover some and not all RPAs the FAA may think this is a less attractive idea. Working with another agency, something the FAA has had difficulties with in other areas, for only part of the solution may make the FAA look for another solution. Aside from the concerns in establishing how RPAs will communicate with their operators, is the concern of what occurs when communication is lost. The FAA has no current method of modeling or predicting where an RPA would go after communication is lost. This issue is one of the reasons that the FAA requires other government agencies, like the Department of Justice (DOJ) to keep all RPAs within visual site as outlined in their Memorandums Of Understanding (MOU) (Airborne Law Enforcement Association, 2013).

Another safety issue the FAA faces that is commonly ignored is establishing RPA design standards. The FAA sets standards or specific guidelines for how an aircraft must be built; they will eventually have to do the same thing for RPAs as well. It is a difficult task as RPAs are being built before the FAA has finished creating regulations or deciding on what the standards should be. Particularly difficult to deal with, is the severe immaturity of RPA designs. As mentioned previously, RPA designs have followed traditional aircraft designs. Over time, this could change as engineers become more comfortable building craft without concern for onboard humans. New, more radical aircraft designs could make it difficult for the FAA to establish criteria that deal with problems like wake vortex or turbulence avoidance (Federal Aviation Administration; UAS Aviation Rulemaking Committee, 2013). A non-traditional craft may take longer for the FAA to process because of these unique characteristics.

Landing and takeoff procedures are of particular concern in how they affect the safety of airports. The FAA currently only has safety standards for how to land a manned aircraft at an airport. Certain aspects, such as time to comply, are unknown for RPAs. Currently, air traffic controllers give pilots direct commands such as “turn left heading 270, maintain FL250” (Federal Aviation Administration; UAS Aviation Rulemaking Committee, 2013, p. 18). Air traffic controllers have no way to issue these commands to an incoming RPA, and have no idea how long an RPA would take to process the information.

As of right now, the FAA is ensuring safety by integrating slowly, allowing authorization to operate RPAs to only certain small areas. At the same time, they are trying to implement the NextGen project which will allow the aviation to operate at a much more digital level. With all manned aircraft equipped with ADS-B systems, or Automatic Dependent Surveillance-Broadcast systems, giving aircraft the ability to broadcast its position and velocity. RPA could be integrated much more easily since they would be able to ascertain the exact position of other craft. ADS-B and ABSAA would allow all aircraft to communicate with each other and create a more digital NAS network (Lacour & Wilson, 2013), which would help handle RPA integration.

Safety is the FAA’s preferred area of expertise. This has not entirely made up for the newness of RPAs, but the FAA has tried to outline what it wants for safe integration. Many of the technologies the FAA deems necessary for RPA integration are either still in development or too untested for the FAA to trust. Delays for full integration are inevitable until the FAA fully trust technologies that have never been used before. A partial integration for small RPAs is possible if the FAA adjust to the requirements of low altitudes. The FAA has a very clean record in aviation safety, which is why RPAs are moving slowly, the FAA does not want to risk this record. However, in order to successfully integrate RPAs into the NAS soon the FAA will need to adjust and rely on technologies that have already been invented. This could be done with a more focused approach on small RPAs, which remain the bulk of desired use at the moment.

**Amazon**

One of the most notable commercial applications of drones in the bulk of small RPA uses, to most Americans, is Amazon Prime's RPA delivery system. After Jeff Bezos, the CEO of Amazon, told correspondent Charlie Rose about his plans to use octocopters to deliver packages, the idea of RPAs being used within America became more widespread. Since Amazon Prime's octocopters have become such a main focus point in the average American's conversation about RPAs, it is necessary to give it a special analysis. There are many implications in the meaning of Jeff Bezos' announcement about Amazon Prime using octocopters for deliveries, each with opportunities and issues that need to be broken down and addressed.

Ignoring any technical concerns with Amazon Prime's RPAs, there are still several legal and policy issues. One of the public's main concerns is: "what will keep people from shooting them down?"(Cummings, 2013). The simplest answer is the law will. In fact, after a proposal to "grant hunting permits to shoot down drones" in Colorado, the FAA said, "Shooting at an unmanned aircraft could result in criminal or civil liability, just as would firing at a manned airplane," (Ferner, 2013). According to United States Code title eighteen part one chapter two subsection thirty two:

> ...whoever willfully sets fire to, damages, destroys, disables, or wrecks any aircraft in the special aircraft jurisdiction of the United States or any civil aircraft used, operated, or employed in interstate, overseas, or foreign air commerce shall be fined under this title or imprisoned not more than twenty years or both. (18 U.S. Code Section 32 – Destruction of aircraft or aircraft facilities, 2014)

At the moment this law would have little reason to be adjusted or changed for RPAs. Until this law is adjusted it would apply, to anyone damaging any RPA for whatever reason, "not just people who hate drones", but also "people who want those packages" (Cummings, 2013). Meanwhile, in Illinois for example, someone who "takes a motor vehicle from the person or the immediate presence of another by the use of force or by threatening the imminent use of force. . . [can be punished by up to] 15 years" (Carjacking/Vehicular Hijacking, 2010). This would be applied in cases where someone robbed the local FedEx truck that delivers amazon packages now. So, while it may seem easier to the average criminal to rob Amazon's remotely piloted aircraft, the punishment for stealing one five pound package from an RPA may actually be far more than stealing the actual delivery truck. This is an example of the severity of punishment that could be dealt for attacking RPAs. It should also be noted that as a general rule, in most states, the punishment for robbery declines to some degree according to the type of weapon used, while the method of attacking an aircraft, even a remotely piloted one, is not separated to different levels of punishment based on weapon choice. Attacking a delivery truck would be punished less severe if it was done using a less dangerous weapon, while attacking an RPA would be punished to an equal severity no matter how it was done. Clearly the motives for attacking a remotely piloted aircraft are also not listed either. Currently, there is no legal exception for shooting down a RPA because of: trespassing, privacy concerns, a general hatred of RPAs, or stealing; all of these cases would violate the exact same law. As far as Amazon Prime is concerned, they will be heavily protected by laws already in place. These laws would have very little reason, in the foreseeable future, for being reduced in any way that would affect Amazon.

Aside from the danger of Amazon Prime deliveries being shot down, the much larger issue is Jeff Bezos' proposed timeline for Air Prime distribution. He claims these deliveries will start being made within four to five years, which is much more than a "little optimistic" (Bezos & Clark, 2013). Based on what Bezos indicated in his interview with Sixty Minutes and what Amazon has posted on its own website, the goal for Amazon Prime remotely piloted deliveries is to focus on small package transport inside of major cities near Amazon's distribution centers (Bezos & Clark, 2013). These cities have not been specified at this time. As Bezos admitted in that interview, the earliest possible time for any RPA to fly commercially, for profit, inside the United States is September of 2015.This is when FMRA, passed by Congress, "tasked the Federal Aviation Administration (FAA) with safely integrating drones into the national airspace system by September 2015," (Dolan & Thomson II, 2013). However, this deadline has already faced several problems, because the FAA has failed to meet several of its key deadlines. In the particular case of small RPAs flying in heavily populated areas, like Amazon deliveries, the FAA initially planned not to have full legal regulations or integration at that level until at least 2018 (LaCour & Wilson, 2013). This was the FAA's best possible scenario for integration over populated areas in low density airspace. Most major cities, however, do not have low density airspace. As of June 2013, the FAA estimated it will take at least another 10 years for RPAs to be integrated into heavy traffic airspace over major metropolitan areas (Federal Aviation Administration, 2013). Since that time the FAA has not met several of its general deadlines. Given that the FAA has consistently failed to meet many of its deadlines for integration, and their estimates for RPA integration needed for Amazon deliveries were already as far away as 2023, it seems clear that Amazon will be waiting much longer than what Bezos initially indicated.

A multi-billion dollar company like Amazon would have been highly likely to have researched all of these laws before doing any major research and development. This makes it all the more likely that Amazon had no real plans to start delivering packages using remotely piloted aircraft anytime soon. Also it is worth noting the date of the Sixty Minutes interview, and subsequent *unveiling*, as being very close to Christmas. Given that Christmas is a major shopping time for most Americans and consequently a major business opportunity for Amazon, it is not surprising the announcement took place right before Christmas. Interestingly enough "the entire 2013 holiday season was [its] best ever, with more than 36.8 million items ordered worldwide on Cyber Monday, or, Amazon said, 426 [items] per second" (Post Wire Report, 2013). This is not to say that Amazon would not have had record Christmas sales or that they are not serious about using RPAs down the road, but given the announcement's timing and the fact that Amazon is almost certainly aware that they will not be delivering packages with their Prime Air services for over a decade; it seems fairly clear this was an easy way to market Amazon Prime during the Christmas season.

Amazon may one day have RPAs deliver packages to the majority of their customers. FAA regulations, however, will certainly slow the timeline of deliveries down. It is unlikely Bezos was unaware of this when he announced Amazon Air Prime, leading to the likely conclusion that the announcement was more about delivering packages in the 2013 Christmas Season, instead of delivering packages with RPAs.

**Economics**

Despite the delays in RPA use for delivering packages there is still a large amount of economic benefit that could be tapped into right now. Even people who are generally opposed to RPAs are usually still intrigued by the possible economic benefits of domestic RPA use. The Association for Unmanned Vehicle Systems International (AUVSI) had Darryl Jenkins and Doctor Bijan Vasigh put together an economic report on RPA integration, a report that has been widely cited in the debates over RPA integration. Very little research has been done with regards to the economic benefits of RPA commercial application aside from this report. The study put out by the AUVSI predicts several changes to the national economy, but is based on several assumptions.

One of the primary assumptions the report makes is that the FAA will complete all of its mandated tasks on time. This has clearly not happened, and will likely not happen for any of the future goals as well. According to Vasigh and Jenkins these delays have a potential economic impact of $10 billion each year (Jenkins & Vasigh, 2013). This was estimated in 2013 based on what would happen if the FAA failed to meet its mandates. Most of the report, however, was based around the FAA completing its objectives on time. This assumption is one of the reasons why the report mainly looks at the 2015 to 2025 year frame. As the FAA falls behind schedule, this timeframe also adjusts. By extending the amount of time before integration begins, certain aspects of the report become distorted.

One of the changes caused by delaying integration also intersects with one of the assumptions made in the report. The assumption about rate of adoption was based on the notion that the U.S. would mimic Japan’s fast adoption rate (Jenkins & Vasigh, 2013). This is a large assumption that ignores large cultural differences between Japan and America. For instance Japanese companies and American companies negotiating the transfer of a new technology tend to take different viewpoints on how the technology is assessed. Specifically, Japanese companies prefer to separate the conversation of quality from cost, considering only whether the technology is of value regardless of cost. While American companies combine the two, weighing cost with quality at the same time (Kumayama, 1991, p. 60). This type of cultural distinction would make Japanese farmers more willing to adopt a technology that is better than their current techniques, but the whether or not it was cheap would be a secondary factor. American farmers on the other hand would only adopt the technology if it was a combination of cheap and good. Since RPA costs has dropped since their introduction to Japan and will likely continue to drop in cost, this would boost the adoption of RPA use as Americans focus on the amount of money RPAs would save, regardless of how good or bad the technology is.

The AUVSI report also takes into consideration that RPAs were completely unknown to the Japanese when they began to adopt the technology. Americans will have more familiarity with RPAs when they are finally legalized (Jenkins & Vasigh, 2013). This ignores the significant stigma RPAs currently carry, or assumes it will be overcome as ‘drone’ is replaced with RPA or UAV. This replacement of the word ‘drone’ will be difficult to achieve without many other issues, like privacy, being dealt with first.

Another major assumption the report made is that RPA manufacturing will follow the same pattern as other aerospace manufacturing. Also since agriculture will be one of the significant industries to use RPAs, states with strong agricultural sectors were calculated to benefit more. These assumptions played heavily into which states Jenkins and Vasigh felt would benefit the most from RPAs, preferring states with large aerospace manufacturing already in place or a sizable agricultural sector. Making states like California look to gain “the largest economic and employment impact” from RPA integration since the state contains extensive portions of both industries (Jenkins & Vasigh, 2013, p.14). Since the time of the report though, and possibly because of it, other states have made moves that change their forecast. States like North Dakota, which was predicted to get minimal benefits from RPAs of only a hundred or so jobs and $10 million of economic impact, are now one of the largest players in the domestic RPA industry. North Dakota has made significant strides in adopting RPAs before other states, as Barry Milavetz indicated during an interview, “the state of North Dakota put up $5 million dollars to be able to develop and put up a test site as soon as possible” (personal communication, March 12, 2014) This helped secure one of the six test sites in North Dakota. Milavetz also noted that North Dakota intended “to be one of the first test sites to be fully operational” (personal communication, March 12, 2014) The University of North Dakota has also pushed the state onto the short list of states benefiting economically from RPA, by increasing the number of Unmanned Aircraft Systems Bachelors majors tenfold between 2010 and 2011 (Palmer, 2012). Changes like these would have been impossible for Jenkins and Vasigh to predict, but will play large roles in where RPA industry develops.

Overall the economic forecast of benefits for RPA integration is very high, with the creation of over 100,000 jobs, a large portion being high-tech, high paying manufacturing jobs. Estimates for job creation and large economic impact are likely to remain waiting until regulations are in place. Locations and states that receive maximum impact and the majority of jobs will most definitely change from what was initially indicated. This is noted in the AUVSI report stating that “states that create favorable regulatory and business environments for the industry and the technology will likely siphon jobs away from states that do not” (Jenkins &

Vasigh, 2013, p.3). This part of the report was difficult, if not impossible, to calculate and will be one of the largest shifts from the initial projections. It is an important shift to note because the data indicates that the top ten states to benefit from RPA integration were originally supposed to gain over half of $82 billion of impact. Now that states slated to be at the bottom have started to make pre-emptive moves before regulations are finalized; this will change.

Little debate remains over the fact that there will be large economic benefits from integrating RPAs into the NAS. The argument that remains is which states will benefit the most this new technology. The economic report gives clear numbers but many things have changed, even in just the last year. The longer the FAA takes to finalize its rules the bigger head start states like North Dakota will be able to gain, changing the predicted landscape or the RPA industry. Originally this report was designed to show states how much they could gain from RPAs, possibly prompting them to put pressure on the FAA to move quicker. Instead states have worked to change the report's predictions.

**Agriculture**

One of the largest areas indicated for economic impact of RPA integration into the NAS is agriculture. This is not only an important factor for the United States, but will impact the entire world. The forecasts for 2014 by the United States Department of Agriculture are valued at over $28 billion in exports for grain and feed alone (Economic Research Service and Foreign Agricultural Service, 2013). The United States is one of the world's leading suppliers of agricultural needs, which makes any changes to the field of agriculture within America, significant across the globe. There are two very popular options for use of RPAs in agriculture depending on what the RPA is equipped with. As Jerry LeMieux said "if you use near infrared frequencies you can see if the crops are stressed or not" (personal communication, February 27, 2014) This information could end up saving large portions of crops. Allowing farmers to constantly check their fields, with the ability to monitor each section independently would be beneficial, since the average farm is now around 441 acres ("Promote Ag Day," 2014). Due to this, universities like the University of North Dakota have already implemented programs that teach farming specific RPA. The cropcam RPA, for example, can "allow producers to detect, locate and better assess the actions required to correct the problem [with the crop]" ("Benefits," 2014). RPAs are applicable to all types of farming, and are especially beneficial to cattle and ranch style farming. Jim McCann, president of the Missouri Cattlemen's Association, predicts "[RPAs] would cut your time by probably 75 percent"(Lamb & Globe, 2014).

Application is another key use for RPAs, one that could save large quantities of pesticide, fertilizer, and herbicide. Using RPAs to deliver the chemicals that farmers use to protect their crops, could allow for reductions in the amount used. Combining the two uses of RPAs would allow farmers to spot a small problem area and then take the necessary steps to stop the problem before if advances. This would potentially limit the need to spray an entire field with chemicals saving farmers money, and making environmentalists happier.

Integration of RPAs into existing technologies would not be difficult given how advanced the typical modern farm is in the 21st Century. Tractors, for example, are already equipped with GPS technology to help drive in straight lines across large fields (Gould, 2013). Farmers are already familiar with these types of technology; integrating RPAs would only be a simple system swap. This is also one of the areas of least concern for most regulators and privacy advocates as these flights would be in remote and isolated areas at low altitudes. Privacy advocates would have little to worry about in the way of spying simply because most farmers would have little to spy on. The FAA is also much more lenient with flights in remote areas away from anyone and far below any other aircraft. This potential agricultural boom is another possible reason that the FAA has tried to stay on track to release at least some rules for small RPAs.

Agriculture is the largest field of application for RPAs. RPAs are a revolutionary technology, but agriculture has become increasingly high tech, making the adoption of RPAs much simpler. The effects of America increasing its crop yield significantly will ripple across the globe. Japan’s own RPA agriculture revolution was not noticed by the average American, but the future American RPA agricultural revolution will almost certainly be noticed throughout the world.

**Privacy**

Privacy has been one of the largest and most prevalent issues in the news that most people know about RPAs. The FAA has repeatedly tried to avoid regulating privacy laws. Without the FAA regulating or any Congressional legislation, a vacuum has been generated over what exactly the rules are about privacy. This vacuum has allowed several states and even towns to legislate their own laws about privacy that have varied widely across the country. For instance in North Dakota the police have plans and regulations in place for using RPAs to locate a missing person or help in the event of an active shooter that have been created with input from the community (B. Milavetz, personal communication, March 12, 2014), while in Colorado rules have been proposed to give awards for ‘hunting’ drones (Ferner, 2013). This could be problematic down the road, since as Jim Poss CEO of ISR Ideas and Director of Strategic Initiatives for Mississippi State University notes, “there is no such thing as local control of airspace . . . [because] at 30,000 feet you just don’t see those dotted lines anymore” (personal communication, March 13, 2014). The unique aspect of RPAs being able to rapidly cross over different jurisdictions is what makes it necessary to have at least a framework for privacy regulations. This framework should be consistent across the country for all law enforcement, journalistic, and private commercial RPA operators, since each has its own unique aspects of privacy law.

Law enforcement or government use of RPAs is one of the most controversial points in any conversation about RPAs. Much of the debate can be cleared up by first understanding the rules regarding manned aircraft, as these would likely apply at the minimal level to RPAs. There have been several cases in court that have established a precedent for what the police can and cannot do from the air. Many RPA advocates, like Doctor Jerry LeMieux, argue that police using

RPAs changes nothing, arguing that “it is the same exact mission as [the police] have always done”, regardless of the position of the pilot (personal communication, February 27, 2014).

The rules and restrictions on police using regular manned aircraft have an extensive history based on multiple court rulings. For instance, in 1986 in *California v. Ciraolo*, the Supreme Court ruled in favor of the police after they flew an airplane over Ciraolo’s home, after a tip, and spotted marijuana in his backyard without a warrant (46 U.S. 207, 1986). The argument the Court agreed with, was that Ciraolo’s backyard was open to the public. In this case, the public would be any person that happened to fly their airplane over Ciraolo’s property and looked down, spotting the marijuana. This case was expanded further three years later in *Florida v. Riley* when the same thing happened, except instead of Riley’s backyard it was his greenhouse. This seems trivial, but is very telling, because the Courts ruled that since some of the panels were open on the roof of the greenhouse it was still a case of open to the public, despite the marijuana being inside a building (ACLU, 2011). The distinction between what is inside and what is outside is important because the precedent has been that “conducting surveillance of a person while within the confines of his home [constitutes] an intrusion upon seclusion” (Dolan & Thomson II, 2013, p.15). Intrusion upon seclusion being the key phrase the Court uses to help decide most privacy cases. Intrusion upon seclusion coupled with the ruling in *Dow Chemical Co. v. United States* which was about surveillance of a chemical company provides a strong base for RPA privacy rules. In *Dow*, the Court ruling dismissed the case because the technology used was just an average camera, suggesting that using technology that is outside the reach of the public would have been illegal without a warrant (*Dow Chemical Co. v. United States*, 476 U.S. 227, 1986). This argument would effectively bar a police operated RPA from looking inside someone's home without a warrant, even if it was equipped with thermal imaging or other specialized sensors.

However, these limitations do nothing to keep law enforcement from flying overhead and observing anything that a normal person could see. Using this "binary concept of privacy", where the only limitations come from the boundaries of one's home does not take into account certain elements of RPAs (Brennan Center for Justice, 2013). RPAs have certain advantages over manned aircraft in regards to initial and operating cost that would allow law enforcement to expand their aerial presence significantly. This would add a "multiplier effect [because] you can only have a finite number of police officers patrolling" (personal communication, March 5, 2014), or flying at any one time. This is presumably why sixteen law enforcement agencies have been authorized to use RPAs with COAs, because the additional work that can be done using RPAs versus the manpower and cost required is fairly low compared to traditional methods of police work. As Diana Cooper, a lawyer at Weinstein LLP, said during an interview, "giving efficient power to one group is very dangerous" (personal communication, March 7, 2014). Police being able to cheaply and easily get aerial surveillance constantly could provide more power to local law enforcement than people are comfortable with. In essence, RPAs would allow police to overcome practical concerns with using aircraft, which until now were "the greatest protections of privacy" (*United States v. Jones*, 2012, p. 14). Without that protection the only limits left are the walls of an individual's home, leaving anywhere else people travel outside those walls open to monitoring. As Diana Cooper said, "you can gain a lot of information just by following someone around with a drone, if you don't need a warrant to do that then you have a problem" (personal communication, March 7, 2014).

The courts have hinted that they may not allow any type of constant warrantless surveillance, like RPAs are capable of, saying in cases with GPS tracking that "monitoring generates a precise, comprehensive record of a person's public movements that reflects a wealth of detail about her familial, political, professional, religious, and sexual association" (*United States v. Jones*, 2012, p.7). This is not a guaranteed protection against RPA abuse, even if the Court does adopt this same stance for RPAs, this would still take time to work the legal issues out through the court system.

Without any legal boundaries one of the main guards against any type of police abuse of RPAs is individual department choices. In an interview with Michael Fergus, of the International Chiefs of Police Association, he spoke about the reasons police want RPAs, the main one being "to improve situational awareness"(Fergus, 2014). Fergus also made the point that "[police] don't want to use [RPAs] for patrol" (Fergus, 2014). However, while this may be true for the majority of law enforcement, there will always be departments that go further. Departments like the local police in Grand Forks who were assisted by the Customs and Border Patrol's (CBP) RPAs with general police work and without public knowledge or debate. This type of use was never discussed when Congress allowed the CBP to purchase the RPAs (Bennett, 2011). This kind of legal but undiscussed use of RPAs is one of the primary dangers of law enforcement gaining RPAs.

The problems with encroaching on privacy rights are currently only restricted, technically, by the practical issue of "how [many] resources can the police put towards analyzing the data gathered" (personal communication, March 4, 2014). Data analysis is "a limiting factor now but [will not] always be" (personal communication, March 4, 2014), which is one reason that these issues need to be decided now. Policy for RPAs needs to be "proactive not reactive" as

Diana Cooper stated, so that as these technical limits disappear the legal boundaries for law enforcement using RPAs are already in place (personal communication, March 7, 2014).

The issue of privacy is different for journalists and the news media. The rules and regulations, as well as the protections that journalists have make the introduction of RPAs complicated. Since 2010, journalists have cited a RPA that provided video for ABC-TV in Afghanistan as ‘proof of concept’ in validating the notion of RPAs playing a role in news gathering (Corcoran, 2010). Journalists have used many technologies to gather the news over the years and RPAs are one of the latest technologies to emerge in the 21st century. As Matthew Schroyer founder of DroneJournalism.org said during an interview, “you have to do it all to keep pace.” This is an accurate description of the current status of the media industry, which has yet to fully define its use of RPAs.

The first step to defining how the media may use RPAs is to first understand what the legal limits are. While there are no specific RPA laws, there are still plenty of laws on the books with regards to the news and privacy. These laws would be a natural boundary for journalists using RPAs. Journalists have a particularly interesting relationship with the privacy law, because the right to privacy is also balanced against the “right to receive news” (*Kleindienst v. Mandel*, 1972). This *right to receive news*, however, is not to be construed as immunity for journalists trying to gather information. It is protection for the First Amendment, which the Court elaborated saying the public is entitled to the right to receive. This concept is important to point out so that it is clear that journalists have no special privilege to invade the rights of others (*Cohen v. Cowles Media Co.*, 1992). This is not to say the press does not have some First Amendment protections, but that the courts do not want to signal that the press could violate any regulation it considers in its path to gather the news. One of the best examples given by the Court is:

> ...the prohibition of unauthorized entry into the White House diminishes the citizen's opportunities to gather information he might find relevant to his opinion of the way the country is being run, but that does not make entry into the White House a First Amendment right (*Zemel v. Rusk* 381 US 1, 17 1965)

Applying this same argument to RPAs makes it clear that any restrictions the FAA or Congress were to add would supersede any First Amendment protection, especially in cases where other means of newsgathering were available.

Using other more traditional means of newsgathering when possible is the first block of Matthew Schroyer's "hierarchy of ethics" (Schroyer, 2012). The idea behind this is that RPAs are still dangerous no matter what precautions are taken, so if this danger can be removed by using another method of collecting data then it should be. This may be true for the moment, but "[a]udiences have grown to expect events to be portrayed and stories to be told from multiple viewpoints," adding "[a]erial photographs and video adds context to story, [and] provide rich illustrations of the scale [of news]" (Corcoran, Goldberg, & Picard, 2013). This expectation will likely mean that, in order to meet the public's desires, the press's use of RPAs will transition from supplementing traditional news stories to becoming a key, necessary part of all news stories. This necessity will eliminate the largest block on Schroyer's "hierarchy of ethics" as almost every story will be considered newsworthy enough to use a RPA.

As RPAs become more standardized as basic equipment for all journalists, the boundaries of privacy will certainly be tested. This has already begun in cases like Pedro Rivera a photographer for a local TV news station that was apprehended by police while he used a RPA to record a crime scene. The lack of clear and definite FAA rules on any aspect of RPAs makes cases like Rivera's somewhat murky, where RPA use turns into a legal battle. The "shake up" as Schroyer says is happening now.

While the press does not have any special privileges to use RPAs in a way that private citizens could not, they do have the risk of wanting to use RPAs in ways that private citizens would not want to use them. For instance the paparazzi have already begun to use RPAs to take pictures of celebrities in countries where regulation of RPAs is somewhat looser. The issue of RPA climbing to a 30th-floor hotel window to catch a celebrity in an indiscrete moment has already been labeled as a potential 'million-dollar money shot' (Corcoran, 2012). This makes the need for regulations that much more necessary. Things like the "hierarchy of ethics" for drone journalism are a good start, but still have gaps where regulations for safety and privacy are absent. Journalists have many of the same issues as police, only with different reasons. This is why rules need to be placed to set limits on RPA surveillance and using RPAs to follow celebrities or politicians 24/7.

Private operators and commercial operators have different issues with privacy than police or journalists. They present a much larger category of issues because their operations can vary as greatly as they can imagine. This makes it hard to define any comprehensive regulations on how a private operator can fly before violating a private citizen's privacy rights, as the needs of commercial operations can change as quickly as ideas for RPA use spread.

The current rules regarding privacy for manned aircraft are well established by multiple court rulings on almost all uses of aircraft and create a good starting point for a large portion of privacy issues. As Tim Ford, CEO and President of AeroUAVs, said in an interview "The privacy laws are already there" (personal communication, March 1, 2014) RPAs that operate identically to regular aircraft, with the absence of a pilot being the only difference, easily fall under the scope of *United States vs. Causby*. The court concluded, in the case of *Causby* that "flights over private land are not a taking, unless they are so low and so frequent to be a direct and immediate interference with the enjoyment and use of the land." There have been several other cases since *Causby* that have had slight differences in determining if an aircraft had violated a person's private rights by 'taking' their airspace, but the constant throughout these cases has been that the flights must disrupt the use and enjoyment of the land (Dolan & Thomson II, 2013). As far as what disrupts the use and enjoyment of land, the courts have been fairly consistent, only considering cases with significant and obvious problems. Generally, for regular manned aircraft, these problems have arisen from either the noise, vibration, or dust from aircraft flying overhead (Dolan & Thomson II, 2013). These cases have all required a significant burden to the private individual, not simply a dislike at the thought of aircraft flying overhead. All of these issues, that the court has accepted for claim of taking, would be less severe for RPAs compared to average manned aircraft, since RPAs are typically quieter with smaller less disruptive engines. These characteristics would lessen the chance that they would present a legal issue in court. The Court has also said that "a property owner owns only as much air space above his property as he can [practicably] use" (*Geller v. Brownstone Condominium*, 1980). Applying these rulings to the RPAs that operate similar to regular aircraft would protect most RPA flights from *taking* charges.

While these cases have usually revolved around taking claims, they would likely apply equally to trespassing and nuisance claims. The differences in taking compared to trespassing and nuisance claims is mainly that taking involves the government, while trespassing and nuisance involve individuals violating other individual's rights. Nuisance and trespassing are technically different from each other in legal arguments. Nuisance includes being concerned with disturbing someone on their land instead being based only on disturbing someone. Since the

Court's rulings have regularly based both claims only on how the flights have affected the use and enjoyment of the land, the two claims are dealt with similarly if not entirely identically.

Using current arguments regarding nuisance and trespassing could easily provide a legal framework to protect RPAs operated privately as long as they were flying outside of the airspace generally controlled by an individual. There is also legal precedence for RPAs using cameras to navigate. In a case where a couple sued for privacy violation against a company whose maintenance workers looked over into their yard while working at an adjoining property, the Court ruled against the couple because the workers were merely conducting their work (Dolan & Thomson II, p. 16).This could be applied to RPAs that may view a private property as they fly by or around the property. This would protect the operator's ability to 'spy' on a private individual's house in order to avoid crashing into it. The recording of these images would be a different matter. In cases where people's homes have been photographed the court has based its decisions on whether the photographers were "unreasonably intrusive" (Dopp v. Fairfax Consultants, LTD., 1990). These cases would likely allow RPAs to use cameras and possibly even record their flights, as long as they do not intrude into the private spheres of a person, which have been set as inside private homes and secluded areas.

It is difficult to predict what the Court rulings would be, but as Faye Jones said during an interview "every instance is very fact specific" (personal communication, March 4, 2014). This is something that will be unsustainable as the number of RPAs increases. There are many instances where privacy has been given up, where "we have already chosen to surveille ourselves" (F. Jones, personal communication, March 4, 2014). If people are uncomfortable and want to protect their privacy they will "need to voice their opinion, not [rely on] some government agency” as Michael Khavari of the Rutherford Institute stated (personal communication, March 5, 2014).

One of the solutions to protect people’s privacy outside of their homes is “privacy by design, the idea that privacy should be embedded into design specifications from the onset” (personal communication, March 7, 2014). Limiting or standardizing the types of cameras, sensors, or management of data could help reduce the risk of someone’s rights being violated. While it would not be foolproof as RPAs can always be custom built, it would be a start. First though, people have to decide if they want to protect their privacy.

It is clear from all of this that both sides of the debate over privacy and RPAs are correct, to an extent. RPAs can use all of the available privacy laws that are in place already. Using current laws would be a good start, but it would not be enough to stop privacy violations. RPAs have subtle differences that current laws were not meant to handle. The ability to operate continuously and cheaply give huge advantages over manned aircraft. This is one of the main advantages, but also one of the main concerns. The laws for privacy restrictions need to be hammered out in an open forum, preferably through legislature. If not dealt with promptly by lawmakers then, the FAA will likely let the Courts decide. The Courts could handle this issue, but it will not be quick and will further slow the process of integrating RPAs into the NAS. This is a reason for RPA enthusiasts and privacy advocates to work together to pressure Congress to establish final standardized rules across the country, in the hopes of settling these problems quickly.

## Conclusion

Domestic use of RPAs has become a large and complex issue for most Americans. America has used RPAs across the globe in ways that have concerned some citizens making them wary of applying the same technology in their own skies. This feeling is mixed with a strong interest in gaining the economic benefits of integrating RPAs into the NAS. This will require a delicate balancing act between what the people will allow in terms of RPAs and privacy with what the RPA industry will need in order to operate. Many old rules are applicable, but do not mesh with what average Americans feel is appropriate for RPAs to follow in terms of privacy boundaries. These issues need to be resolved before the RPAs can truly operate in the NAS. The FAA has made it clear they will not deal with the issue of privacy, attempting to focus on what they are familiar with in terms of safety. Even with their strong history in aviation safety the FAA has constantly struggled to meet any of its mandated deadlines. Both the regulations for safety and privacy are far from complete and at the moment neither seems to have any chance of being settled in the near future. This is unfortunate as the benefits in terms of jobs and revenues would greatly boost not only the U.S. economy but positively affect the world, this is exactly the reason to try to accelerate the process of allowing RPAs to operate domestically.

# The Humanitarian Implications of Drones

## Global View of Drones

The United States of America has used drones extensively in its War on Terror, which has brought this technology as a tool of espionage and sabotage into the international limelight. Globally, there are varying views regarding this technology as a weapon and as a tool for surveillance.

In the United States, there is a general support for use of drones in the War on Terror. The public support for this program is related to the concern about future terror attacks on American soil. Recent events like the Boston Marathon bombing have increased public concern against terrorism which creates public support for aggressive foreign policy and drone strikes. As long as American citizens feel threatened, there will be greater support for drone attacks (Fisk, Merolla, Ramos, & Zechmeister, 2013). According to a YouGov poll, 56% Americans agree to the use of drones to kill high-level targets while 13% say that drones should be used to kill anyone suspected of association with a terrorist group (Swanson, 2013). As per a 2013 Gallup poll, 65% of Americans agree to the use of drones to attack suspected terrorists in other countries (Brown & Newport, 2013). Other statistics give similar numbers:

> A new Monitor/TIPP poll finds that a firm majority of Americans – 57 percent – support the current level of drone strikes targeting 'Al Qaeda targets and other terrorists in foreign countries.' Another 23 percent said the use of drones for such purposes should increase. Only 11 percent said the use of drones should decrease. (LaFranchi, 2013)

However, the opinions regarding drone operations change when the drone is targeting an American citizen. Gallup poll of 2013 shows that 52% of Americans did not support drone strikes on American citizens who are suspected terrorists abroad. Similarly, 79% Americans are against drone strikes on American citizens living in the United States who are suspected terrorists. Furthermore, 66% Americans did not support drone strikes on *any* suspected terrorist on American soil as evident in the attached Appendix C. (Brown & Newport, 2013).

In contrast, the public of Pakistan are generally against the use of drones. Pew Research poll of 2013 found out that 68% of the Pakistani public was against drones. Specifically, about 9 out of 10 people in the Federally Administered Tribal Area (FATA) of Pakistan are against drones (Bergen, Doherty, & Ballen, 2010). The government of Pakistan also has a clear stance against the use of drones on their land. In 2012, Pakistan's Minister of Foreign Affairs Hina Rabbani Khar has clearly stated that drones are counter-productive. She remarks:

> You see Pakistan's position is clear today and has been clear in the past. Our position is that this is something which is counter-productive. It is unlawful. It is illegal, and therefore they must cease. This is what the parliament of Pakistan has clearly said ("Pakistan has a clear stance," 2013).

Moreover, at the UN General Assembly in 2013, Pakistan called for immediate end to drone strikes ("Pakistan urges end," 2013).

Drone strikes are widely unpopular in other countries as well. According to the Pew Research Global Attitudes Project, there is a widespread opposition to the United States' drone program against terrorist organizations. In 31 of 39 nations polled, more than half of the population is against the US drones targeting extremists in Pakistan, Yemen and Somalia. Besides the United States, there are only two countries where majority support the US drone strikes: Israel with 64% and Kenya with 56% population approving the American drone campaign, as seen in the attached Appendix C ("Chapter 1. Attitudes," 2013).

> Even though the majority of European public disapproves of drone strikes in countries like Pakistan, Yemen and Somalia, the European Union has remained silent regarding the United States' drone program. The European governments have not yet examined using drones to target extremists outside active war zones which is why they do not have a

> collective position on such use of drones and have not yet decided upon the legal boundaries of using drones to kill outside battlefields (Dworkin, 2012).

These polls are an evidence of the negative opinion people have regarding the United States' drone program. This global public view can be attributed to several elements like the legal issues of sovereignty of nations, civilian casualties, violation of human rights and international humanitarian law. If RPAs are going to be a positive force in the modern world, the United States must listen to the people of the world.

**The Place of Drones in the Military**

Drone technology has been widely used by the US military. CIA controls drone operations in Pakistan, Yemen and Somalia from its headquarters in Langley, Virginia. The US military operates its drones from seven air bases in the United States as well as air bases abroad (Abé, 2012). The Royal Air Force (RAF) Reaper pilots are based at Creech, an airfield near Las Vegas, where they control the aircraft via satellite as they fly over Afghanistan (Rayment, 2009). However, because of the delay in communication, the military crew in Afghanistan control 'launch and recovery' through direct contact with antennae on the aircraft. According to the Royal Air Force website, the crew in Nevada takes over control half an hour after takeoff and gives back the control to Kandahar, Afghanistan, half an hour before landing ("Reaper," 2014). The drone operators work long shifts, as long as 12 hours, and may experience stress due to long working hours (Chow, 2013).

The drone operators sit in front of computer screens to monitor and sometimes eliminate targets thousands of miles away in places like Afghanistan or Pakistan. This is comparable to playing a videogame as there is no direct contact between the operator and the target, and it may be said that such methods of warfare could desensitize the operators to the act of killing. However, what distinguishes the drone operation from a videogame is that the drone operators are fully aware that the targets are real human beings and the distance as well as the lack of contact does not reduce the emotional effect of taking a person's life. In a videogame, there is the replay option that would bring all the characters back to life but in this real-life situation, there is no such option and the drone operator realizes that. "To extinguish a person's life is a very personal thing. While physically we don't experience the five senses when we engage a target — unlike [how] an infantryman might — in my experience, the emotional impact on the operator is equal" explains a retired Air Force Drone Operator (Chow, 2013). Moreover, the drone operator observes a target's life, actions and movements for days before moving ahead and eliminating them. This time duration could lead to the drone operator learning about the life of his or her target which may affect him or her emotionally when eliminating them.

It is argued that drone operators may be more emotionally affected than a traditional soldier or a fighter pilot because of how closely they have to monitor the whole situation before, during and after the hit. Nancy Cooke, a professor of cognitive science and engineering at Arizona State University's College of Technology and Innovation in Mesa, Arizona, remarked that "[t]he big difference is the level of detail that you can see on the ground [and] when you operate a remotely piloted aircraft, even though you're there virtually, you have a lot of information about what's going on, on the ground" (Chow, 2013). A fighter pilot on the other hand flies in, drops the bombs, and flies away; his or her only concern is to not get shot down, while the drone operator is exposed to all details such as the disturbing aftermath of the strikes.

Wayne Chappelle, chief of aerospace psychology at the Air Force School of Aerospace Medicine at Wright-Patterson Air Force Base in Ohio, found that most drone operators, experience combat sensations that are like those of infantrymen on the front lines (Chow, 2013). Chappelle's studies found no evidence that drone operators experience desensitization to the act of killing. The head of the RAF's 39 Squadron – the Reaper unit, Wing Commander Andy Jeffrey explains:

> There is no risk to any of my crews at all. But that does not mean they are emotionally detached from what is happening on the ground. When troops are in contact, you can hear the guns firing, and the stress in the voices of the British soldiers [on the ground]. We know the risks they are taking and we know if we make mistakes, lives can be lost. Every day we fly operations over Helmand – flying the Reaper is not a soft option. (Rayment, 2009)

Moreover, since the drone operators are closer to home in a safer environment, work and home are weakly separated. The long stressful hours at their job seep into their personal lives and impact his or her household. Furthermore, this lack of separation in a soldier's military life and personal life could also lead to Posttraumatic Stress Disorder (Abé, 2012). As the operator experiences everything surrounding the use of drones like the lives of the targets, the moment of execution, the aftermath as well as witnessing the death of his fellow soldiers on the field, he or she goes through emotional trauma like any other soldier but then returns back to home an environment isolated from the battle-zone with no social support like that of an infantryman's military unit. Colonel William Tart, an ex-commander at the Creech Air Force Base, noted that he often used the one-hour drive from work back to Las Vegas to distance himself from his job. Tart says:

> We watch people for months. We see them playing with their dogs or doing their laundry. We know their patterns like we know our neighbors' patterns. We even go to their funerals. It wasn't always easy. One of the paradoxes of drones is that, even as they increase the distance to the target, they also create proximity. War somehow becomes personal. (Abé, 2012)

According to a survey by the Air Force School of Aerospace Medicine, nearly half the operators of UAVs have high levels of 'operational stress' caused by long hours and extended tours of duty (Blackhurst, 2012).

Besides the emotional and psychological impacts of drones on its operators, using such a technology has raised questions about its morality. The question of morality has two sides to it. The first side argues that it is moral to use drones as it is precise, limits civilian casualties and does not endanger the life of a soldier. The second side is that it is not moral to use drones as it gives immense power to hands of drone operators to take a life with just a remote-control and leads to asymmetric warfare where one side has the upper-hand. Moreover, such tactics lead to increase in militant ranks. Both sides of the issue of morality need to be analyzed to reach a conclusion.

Drones, undoubtedly, provide a convenient and safe way to target militants in a region. It keeps the pilot safe and its precision results in fewer civilian casualties as compared to other methods of traditional warfare like putting soldiers on the ground or bombing from a manned aircraft. Bradley Strawser, assistant professor of philosophy at Monterey's Naval Postgraduate School, presents a moral case in favor of drones. Strawser states that “if a particular operation was just, and if using a drone could avert risk to a pilot without compromising the operation, the US had a duty to use drones” (Carroll, 2012). Strawser also comments:

> ...drones can be a morally preferable weapon of war if they are capable of being more discriminate than other weapons that are less precise and expose their operators to greater risk. Of course, killing is lamentable at any time or place, be it in war or any context. But if a military action is morally justified, we are also morally bound to ensure that it is carried out with as little harm to innocent people as possible (Strawser, 2012).

He argues that drone operations are analogous to a situation where a robot is preferred over a human to dispose of a bomb. However, Strawser admits that he only argues in favor of drones as long as the end result is just. He does not support or endorse drones if the mission is unjust and hence agrees to the immorality of drones in such a case. For example, he remarks that in a situation where drones have allegedly killed civilians would be unjustified and hence immoral but this does not delegitimize the technology. Also, he thinks that drones with artificial intelligence make decisions about who to kill is immoral. (Strawser, 2012).

On the other hand, John Kaag and Sarah Kreps provide an analogy between the United States’ drone program and the Ring of Gyges in Plato’s *Republic* to argue against the morality of drones. In the story of Ring of Gyges, the character Gyges finds a ring which gives him the power of invisibility. He uses the ring to kill the king of the land and marries the queen. The ring can be compared to the drone technology and the drone strikes can be compared to the killing of the king. Gyges intended to marry the queen the same way the US wants to fight terrorism. “What is distinctive about the tale of Gyges is the ease with which he can commit murder and get away scot-free. The technological advantage provided by the ring ends up serving as the justification of its use” (Kaag & Kreps, 2012). Similarly, this ease of Gyges killing the king has resulted in avoiding unnecessary killing just like in the targeted killing of terrorists. The moral issue over here is that since Gyges had the power due to the ring, he did not have the moral justification to kill the king. In the case of drone strikes, to say that we *can* target individuals without incurring troop casualties does not imply that, we *should* (Kaag & Kreps, 2012).

The question is not of the morality of drones but of the morality of drone *use.* The case of civilian casualties and how it can give rise to militant ranks is discussed in other sections of this paper which is enough to argue for the immorality of drone use in areas like the Waziristan Agency of Pakistan. Moreover, since target killing has become cheap and convenient because of drone technology and since it provides low troop casualty, there is relatively lower opposition to such wars from domestic elements. This means that “[the] United States and its allies have created the material conditions whereby these wars can carry on indefinitely” (Kaag & Kreps, 2012). Furthermore, this ease in eliminating certain targets using precision-guided missiles would result in “a society with perpetual asymmetric wars” (Kaag & Kreps, 2012).

Morality of drones is an ongoing debate with no definite answer. On one hand it provides a convenient and cost-effective way to target combatants without risking the life of a soldier. It also reduces civilian casualties compared to other methods of warfare. On the other hand it enables drone operators to take a life with the ease of just pressing a button. What must not be ignored is that civilian casualties, no matter what the number, are a consequence of this tactic which makes this method of warfare counter-productive. Whether a single civilian loses his or her life or more than one lose their life, killing a civilian is still immoral and a violation of human rights.

**Drone Use Inside and Outside Warzones**

Drones have formed an integral part of the United States War on Terror. They have been extensively utilized to not only provide support to the on-ground troops in Afghanistan but also in targeted killing of Taliban and Al-Qaeda operatives. Where putting troops on ground is risky or not possible, the US has used drones for targeted attacks. The use of drones in context of War on Terror has two aspects: inside active war zone and outside war zone.

The use of drones inside war zones should follow the same international and humanitarian laws as any other weapon. It should not result in the death of civilians nor should it cross the boundary of war crimes. International Humanitarian Law states: “Civilians under the authority of a party to the conflict or an occupying power of which they are not nationals are entitled to respect for their lives, dignity, personal rights and convictions” (“War and international humanitarian law,” 2010). However, as mentioned in the section “The Case of Civilian Casualties” of this paper, several cases have been reported where civilians have been killed. International Humanitarian Law further states: “No one must be held responsible for an act he has not committed” (“War and international humanitarian law,” 2010). This raises several questions regarding the choice of targets for drone attacks. The covert nature of drone program by the CIA makes it difficult to judge whether these targeted drone killings are going against the International Humanitarian Law or not. Geneva Convention (I) for the Amelioration of the Condition of the Wounded and Sick in Armed Forces in the Field, 12 August 1949, states:

> Persons taking no active part in the hostilities, including members of armed forces who have laid down their arms and those placed ‘hors de combat’ by sickness, wounds, detention, or any other cause, shall in all circumstances be treated humanely, without any adverse distinction founded on race, color, religion or faith, sex, birth or wealth, or any other similar criteria (“Treaties And States Parties To Such Treaties,” n.d.).

These people, according to this article, are also protected from cruel treatment or killing. The article further states that wounded and sick should be cared for. There are instances where these laws were not followed. For example:

> On [June 4th, 2012], US drones attacked rescuers in Waziristan in western Pakistan minutes after an initial strike, killing 16 people in total according to the BBC. On 28 May, drones were also reported to have returned to the attack in Khassokhel near Mir Ali. [Moreover,] between May 2009 and June 2011, at least 15 attacks on rescuers were reported by credible news media, including the New York Times, CNN, ABC News and Al Jazeera (Greenwald, 2012).

Killings where a second drone strike at the same location targeted rescuers and injured do amount to a war crime. According to Christof Heyns (2012), the UN Special Rapporteur on extrajudicial killings, summary or arbitrary executions, "there have been secondary drone strikes on rescuers who are helping (the injured) after an initial drone attack, those further attacks are a war crime" (Greenwald, 2012). There is no doubt that there have been civilian casualties and there have been cases where multiple drone attacks were conducted at the same location. The legality of drones in the War on Terror is an international on-going debate but one thing that cannot be ignored is the fact that drones are a weapon and hence should be treated like any other weapon as per international laws inside a declared war zone.

On the other hand, use of drones outside active war zones is a different matter. The legality of such use has been discussed in the section "International Aspect" in this paper. There are a lot of issues regarding the humanitarian aspect of drone use outside war zones. Humanitarian organizations and organizations like Reprieve have been openly advocating against drone attacks in regions like Waziristan Agency of Pakistan. Jennifer Gibson, who leads Reprieve's work related to drone attacks in Pakistan, in an interview, stated that "[Drones] should not be used in Pakistan by the US as the US is not at war with Pakistan" (J. Gibson, personal communication, March 10, 2014). She also remarks, “according to human rights law, you cannot just go and kill people [outside a war zone using drones]” (J. Gibson, personal communication, March 10, 2014). The International Declaration of Human Rights states in Article 3: “Everyone has the right to life, liberty and security of person” (“The Universal Declaration of Human Rights,” n.d.). This right of the people of the Waziristan Agency has been violated several times when civilians have lost their lives in drone strikes as mentioned in the section “The Case of Civilian Casualties.” When such rights are taken away from these people, they harbor enmity against the US.

The matter of concern in this context is the question of whether these drone strikes reduce the number of militants or does it help increase it. Those in favor of the use of this technology to conduct targeted killings argue that drones are precise and the best alternative to other conventional methods like bombing with a manned aircraft or putting troops on ground. They also argue that drone operations result in zero to very few civilian casualties in collateral damage (Byman, 2013). The issue with the claim of civilian casualties has been talked about in the section “The Case of Civilian Casualties” but what must be noted is the fact that these civilian casualties are testimony to the violation of The Universal Declaration of Human Rights. Also, as discussed in a later section, the use of drones to target militants in tribal areas of Pakistan is counter-productive and increases sympathy for militants amongst the locals. Ayesha Gulalai Wazir, Member of National Assembly of Pakistan, belonging to the region of Waziristan Agency has stated in an interview that “drones are making people angry as they lose their loved ones. They, then, sympathize with the Taliban and join their ranks as a way to seek revenge” (A. G. Wazir, personal communication, March 8, 2014). Jennifer Gibson also remarked in her interview that drones are imprecise and counter-productive, and the approach of negotiations should be adopted (J. Gibson, personal communication, March 10, 2014).

No matter what the number of civilian casualties, every life matters as per the Universal Declaration of Human Rights and hence an approach should be adopted where there are zero casualties. Furthermore, even inside a war zone, non-combatants should not be killed as per International Humanitarian Law.

**The Case of Civilian Casualties**

The issue of statistics regarding combatants and noncombatants killed in drone strikes is a topic of much debate. The statistics provided by humanitarian organizations are usually contradictory to the statistics released by the US government. Undoubtedly, innocents have been killed in drone attacks. Even President Obama, in his National Defense address, remarked:

> ...it is a hard fact that U.S. strikes have resulted in civilian casualties... And for the families of those civilians, no words or legal construct can justify their loss. For me, and those in my chain of command, those deaths will haunt us as long as we live… ("Remarks by the President," 2013)

It cannot be denied that drone strikes have killed several top Al-Qaeda and Taliban operatives over the past few years. According to the New America Foundation, since the beginning of Obama's presidency, drones have killed around 3,300 Al Qaeda, Taliban and other affiliate militants in Pakistan and Yemen. Amongst these 3,300 terrorists, more than 50 senior Al Qaeda and Taliban leaders have been killed (Byman, 2013). In Pakistan alone, according to The Long War Journal, 2574 leaders and operatives of Al-Qaeda, Taliban and their allies have been killed since 2006 (Roggio & Mayer, 2014).

On the other hand, when it comes to civilian casualties, official reports from the US Government contradict with reports from several humanitarian organizations. In 2011, C.I.A. officials claimed that since May 2010 not a single non-combatant has been killed while more than 600 militants have been eliminated (Shane, 2011). The same year, in June, "John Brennan, then Obama's top counterterrorism adviser, even contended that U.S. drone strikes had killed no civilians in the previous year" (Shane, 2011). Furthermore,

> ...'a senior administration official' said the number of civilians killed in drone strikes in Pakistan under President Obama is in the 'single digits.' But last year 'U.S. officials' said

drones in Pakistan killed about 30 civilians in just a yearlong stretch under Obama (Elliott, 2012).

The claims from US officials contradict each other and the claims from humanitarian organizations tell a different story. Human Rights Watch claimed that in Yemen, 57 civilians were killed in six selected drone strikes since 2009 which included a pregnant woman and three children. In Pakistan, Amnesty International concluded that more than 30 civilians were killed in North Waziristan region in four of the drone attacks between May 2012 and July 2013 (Whitlock, 2013). Peter Bergen of the New America Foundation estimates that during Obama's administration, drone strikes have killed about 150 to 500 civilians (Byman, 2013). Long War Journal estimates that 156 civilians have been killed since 2006 (Roggio & Mayer, 2014). Furthermore, according to a Columbia Law School investigation U.S. drones killed between 72 and 155 civilians in 2011 (Spritzler, 2012). The Bureau of Investigative Journalism (TBIJ) states that since 2004 there were 383 total strikes and out of 2,296-3,718 total killed, 416-957 were civilians and 168-202 were children while 1,089-1,639 people were injured ("Drone strikes in Pakistan," 2014). In Yemen, according to TBIJ, there 302-451 people were killed in 62-72 confirmed drones out of which 33-82 were civilians and 77-193 were injured (Drone strikes in Yemen, 2014).

These varying statistics can be attributed to the difficulty of getting an accurate death toll of people killed in a drone strike and accurately determining who is a combatant and who is an innocent civilian. While the US government keeps the death count of civilians confidential, the independent, on-ground investigators face other difficulties as well. Since most of the drone attacks in Yemen and Pakistan are conducted in areas that are hostile or hard to access, doing an in-depth investigation is tough. However, some reports with significant civilian casualties cannot be ignored. For example, in Waziristan Agency, Pakistan, at least 40 members of a tribal assembly of elders were killed in a drone strike. The tribal assembly of elders, called a *Jirgah,* is a Pashtun way of making important decisions and resolving disputes through consensus. This particular Jirgah had gathered to discuss and resolve a dispute over land ownership among sub-tribes in Waziristan and their gathering had nothing to do with insurgent activities (Akbar, 2012). Several other such cases have been elaborately discussed in a report called "Living Under Drones" by Stanford International Human Rights and Conflict Resolution Clinic and Global Justice Clinic at NYU School of Law. One such case in the report is of Sadaullah Wazir, a teenager and a former student from the village of Machi Khel, North Waziristan. "Sadaullah Wazir was severely injured in a September 2009 drone strike on his grandfather's home" (International Human Rights and Conflict Resolution Clinic At Stanford Law School; Global Justice Clinic At NYU School Of Law, 2012). "A wall collapsed on him and severed his legs, and a splinter tore into his eye. Two of his uncles and a cousin died in the inferno" (Kazim, 2011). Similarly, in Yemen, near a town called Radda, a drone fired upon a wedding convoy on December 12, 2013. 4 out of the 11 vehicles were destroyed in this wedding procession (Almasmari, 2013). According to a Human Rights report on this incident titled "A Wedding That Became a Funeral," the drone strike "killed 12 men and wounded at least 15 other people, including the bride… witnesses and relatives told Human Rights Watch the casualties were civilians" (Human Rights Watch, 2014).

With all these statistics and data in mind, there are several issues that need to be examined. First of all, the definitions for a civilian and a militant are unclear. The distinction between a combatant and a non-combatant is not well defined. For example:

> ...Mr. Obama embraced a disputed method for counting civilian casualties... It in effect counts all military-age males in a strike zone as combatants, according to several

administration officials, unless there is explicit intelligence posthumously proving them innocent (Becker & Shane, 2012).

This explains why the US official statistics are so low for civilian casualties. Media often divides the casualties of drone strikes into the category of either civilians or militants. The term *militant*, when mentioned in the media often implies that they were rightly eliminated. Associating a person with this term is not enough to legitimize the targeted killing of that person, keeping in mind all the humanitarian and legal issues related to drone attacks. This term also creates confusion whether those killed were high-value targets or low-level militants. “National security analysts—and the White House itself—have found that the vast majority of those killed in drone strikes in Pakistan have been low-level alleged militants”(International Human Rights and Conflict Resolution Clinic At Stanford Law School; Global Justice Clinic At NYU School Of Law, 2012). Finally, an issue related to statistics by media is that the sources of such information are cited as anonymous and there is no clear way to verify the information (International Human Rights and Conflict Resolution Clinic At Stanford Law School; Global Justice Clinic At NYU School Of Law, 2012).

Amongst all these debates, it cannot be denied that civilian casualties are a consequence of the drone operations. The interviews of drone strike victims tell the story of civilian casualties. Madiha Tahir, in her documentary “Wounds of Waziristan” interviews several victims of drones who talk about how drone strikes on them and their relatives have not targeted militants but common civilians including women and children (Tahir, 2014). Ayesha Gulalai Wazir, Pakistani MNA from Waziristan Agency, also confirms in her interview that civilians have been killed and it is having a negative impact in America’s War on Terror (A. G. Wazir, personal communication, March 8, 2014).

**How to Reduce Drone Strikes**

Drones serve an integral role in the War on Terror; however, drones have made the matter worse. In traditionally tribal areas of Pakistan, Afghanistan, Somalia and Yemen, there are codes in place that form the basis of their society. In Pakistan, tribal leaders, religious leaders, and the central government are three pillars of this system. When the central government cannot do much to stop drone strikes, either out of weakness or out of consent, the tribal people take the matters into their own hands.

Numerous drone strikes have occurred in the Federally Administered Tribal Area (FATA) of Waziristan Agency in Pakistan targeting Al-Qaeda or Taliban militants. Drones provide a cost-effective and low-risk method to eliminate an enemy without putting troops on the ground which is why drones have been utilized to fight these militants. Unfortunately, this has instead promoted an increase of militants in the region and abroad due to a variety of reasons. One of those reasons is that the civilian casualties, although lower than other methods of warfare, have played an important role in increasing militancy. The *Pashtuns* of Waziristan, an ethnic group in Pakistan, follow an unwritten ethical code of lifestyle called *Pashtunwali*. Out of the main principles of Pashtunwali, there are two which are noteworthy here: *Nanawatai* and *Badal*. Nanawatai refers to the protection or asylum given to a person against his or her enemies, granted even to one's own enemy, and Badal refers to seeking justice or revenge against wrongdoers (Ali, 2013). Therefore, when a Taliban or Al-Qaeda militant approaches a Pashtun for asylum, the Pashtun will follow the tribal code and grant asylum until the matter is settled through a *Jirga*, a tribal assembly of elders to make important decisions through consensus. The principle of Badal is strictly followed to seek justice or revenge and if justice is out of reach, revenge is their only option (Khattak, Mohammad, & Lee). This concept is important to keep in mind when discussing the implications of US drone attacks in areas like Pakistan and Afghanistan.

Militants could settle down or hide in the tribal areas of Pakistan because of Nanawatai (Toor, 2010). When a drone attacks and kills these militants, some civilian casualties become an inevitable by-product of these attacks. Every casualty gives rise to the hatred and enmity against the United States and Pakistani Government. This is not helped by the pre-existing cultural and religious differences as well as historical actions. The principle of Badal turns these non-militant, tribal citizens into Taliban and Al-Qaeda sympathizers, and some even join the ranks of these organizations. This is called bottom-up radicalization (Gerges, 2013). These strikes even create militants abroad and encourage attacks on US forces as well as the people of the United States. For example, Faisal Shahzad was an American citizen and the person behind the Time Square car bombing attempt on May 1st, 2010. He left a car with explosives in Times Square, and confessed that he acted out of anger over the CIA's Predator strikes in Pakistan (Gerges, 2013). Najibullah Zazi was another American citizen who voluntarily joined the Taliban and Al-Qaeda ranks. He then planned to blow up New York City's subway system, providing another example of this bottom-up radicalization (Gerges, 2013). Hence, it can be rightly said that drone strikes play a direct role in creating more militants and a more radical public.

It can be argued that drone strikes discourage and deter people from militancy. The 'deterrence theory' has been in place since the Cold War. The basic belief behind this theory is that threats can be held over an actor to deter it from carrying out a specific action. If the action were to be carried out, the actor would sustain heavy costs and losses (Intrabartola, 2011). However, the main flaw in this theory in this situation is that it cannot stop an enemy who is not afraid to die. For these militants, the concept of *Jihad* forms the basis of their terrorist activities against the US and its allies**.** *Jihad* literally means ‘struggling’ or ‘striving’ (Kabbani & Hendricks, n.d.). “Islam defines Jihad as striving and struggling for improvement as well as fighting back to defend one's self, honor, assets and homeland. Also, Jihad is interpreted as the struggle against evil, internal or external of a person or a society” (Ali, n.d.). The Jihad which involves military action is considered a ‘minor’ Jihad and is only valid when there is no other peaceful alternative available, while the Jihad for self-control and internal betterment of one’s self is considered ‘major’ Jihad (Kabbani & Hendricks, n.d.). However, the terrorist groups use the concept of Jihad incorrectly to justify their terrorist activities against the US and its allies as a holy war (Handwerk, 2003). For the militants, this holy war carries the reward of *Shahadat.* A person who dies in a holy war is considered to have embraced Shahadat and the person is called a *Shaheed*. Shahadat can be best described as’ martyrdom’ and a Shaheed is a ‘martyr.’ Shahadat, as a status after death, is considered one of the highest honors in Islam (Zaheer, 2013). This concept can be seen at play after the targeted killing of Hakimullah Mehsud, a former leader of Tehreek-e-Taliban Pakistan, by a drone strike. After his death, due to this belief of Jihad and Shahadat, some Pakistani politicians like Munawar Hassan, along with Taliban members, considered him a Shaheed (“Anyone killed by US,” 2013). This shows how cultural and religious elements play an important role in creating more Taliban sympathizers as a result of the US drone attacks.

The clear solution is to reduce drone strikes and open a dialogue with the tribal leaders. Ayesha Gulalai Wazir, a Member of National Assembly of Pakistan from Waziristan Agency, talked extensively about how drone strikes agitate the public in an interview (A. G. Wazir, personal communication, March 8, 2014). She mentioned that the reason for drone strikes is to attack and reduce Taliban numbers but this has the opposite effect, so a different approach needs to be taken: negotiations. Ms. Gulalai said that since drone strikes result in the creation of more Taliban members, these attacks should be stopped first and then negotiations should take place between the government officials and the tribal elders. She also stated that the government of Pakistan needs to understand the system of Pashtunwali and create a system of clear communication with the tribal elders. In this way, an agreement can be reached which would bring peace to the tribal area. Once peace is established, and the increase of Taliban ranks has slowed down, other mechanisms should come into play to discourage people from becoming militants such as providing relief, education and infrastructures to the poor region. This plan would increase the popularity of the government and decrease the acceptance of the militants which would lead to a decrease of Taliban effectiveness. If the original causes for drone attacks, such as to eradicate militants, are decreased, there would be no reason left to conduct any more drone strikes in areas outside designated war zones.

**Conclusion**

Drones are an important part of the US military and have played a crucial role in the War on Terror. However, global opinion shows that the majority is against drones as a tool of warfare, and there is an on-going debate regarding the moral issues associated with it. The United States' use of drones has killed several Al Qaeda and Taliban leaders but it has also claimed many civilian lives; drones are considered to be precise in targeting terrorists yet, evidence suggests that innocent people have been killed by drones. Due to this, humanitarian organizations have advocated against its use in countries like Pakistan, Yemen and Somalia. Humanitarian organizations and drone critics have argued that US drone program has violated international law. Inside and outside a war zone, drones should be subjected to the same international laws as any other weapon but outside a war zone drones are counterproductive as it gives rise to militancy. The option better than using drones outside a war zone, like in Pakistan's Waziristan Agency, is negotiations with the tribal elders. The negotiations would help reduce militancy and aid in the goals of War on Terror. As RPAs become an integral part of the modern society, it is necessary that these issues are resolved. The alternative would be a world where distance does not limit killing and murder would be as easy as just pressing a button. Controls and distance allow a person to kill without regard to humanity.

## The International Perspective

### Definition of War

A war, as defined in *Merriam Webster*, is an organized effort by a government or other large organization to stop or defeat something that is viewed as dangerous or bad (Merriam-Webster, 2014). Wars can be fought for several reasons including occupation, annexation, or resources. *Occupation* is taking control of the region during a war whereas *annexation* of a region means “a unilateral act made effective by actual possession and legitimized by general recognition” (Merriam-Webster, 2014). Most common type of war is conventional or traditional war where nuclear or chemical weapons are not used. Wars can cause total destruction, but at the same time, military or political tension can also be named as a war. A prime example of this is the Cold War where the strained relations and implicit competitions between the Eastern and Western blocks were referred to as *war*. A *war zone*, according to the definition by the online database, *US Legal*:

> ...is a term that is ordinarily seen used in the context of international laws. In the context of international laws, the term ‘war zone’ refers to a specific designated area, on land or at sea, within which the rights of neutral nations are not respected by belligerent nations (2014).

In simpler terms, it is an area where a military attack is going on or a battle is being fought between two entities.

Despite these clear definitions, war and war-zones are still a gray area in terms of International law. In her book, *What is War,* Mary Ellen O’Connell claims that:

> International law has lacked a widely-accepted definition of armed conflict despite the essential human rights and other rules that depend on such a definition. During armed conflict, government forces have ‘combatant immunity’ to kill without warning. They may detain enemy forces until the end of the conflict without the requirement to provide

> a speedy and fair trial. Governments may have asylum obligations or neutrality obligations based on the existence of armed conflict (2012).

It can be seen that during an armed conflict, laws are flexible for the forces when it comes to collateral damage and casualties. Similarly, this can be said about a war zone where the laws are loosely enforced and opposition forces have certain immunities regarding what they do in a war zone. For example, recent conflicts have shown that anti torture treaties are not strictly followed. This means that government or opposition forces will not be answerable to any higher authority for the killings they commit during an armed conflict or in a war zone.5

On the other hand, in a non-war zone, international laws prohibit direct killings and combatant immunity because there is no official war going on. All sorts of killings or military operations by opposition in those areas can be termed as the violation of the sovereignty of the host country. Sovereignty, as defined in *Black's law dictionary* is:

> ...the supreme, absolute, and uncontrollable power by which any independent state is governed; paramount control of the constitution and frame of government and its administration; the international independence of a state, combined with the right and power of regulating its internal affairs without foreign dictation; also a political society, or state, which is sovereign and independent (2014).

Any foreign dictation or military involvement can be seen as a violation of its sovereignty by the home country. Sovereignty is further discussed in one of the reports, *The Rule of Law: State Sovereignty vs. International Obligations,* by Renata Giannini. The report emphasizes that concept of sovereignty was born with the raising of the international system in the treaty of Westphalia in 1648. External involvement and interference was unimaginable and forbidden. The modern United Nations (UN) charter uses the same approach when it states that international

[5] Not all actions may be excused in an active war zone, however. Crimes against humanity and "war crimes" may still be subject to prosecution after the conflict ends.

interference in domestic sphere is forbidden in its Article 2. However, the report argues that a room for external interference yet remains when the charter urges promotion of democracy, protection of human rights and fundamental freedom as its primary goals.

One of the primary reasons drones are not illegal when it comes to international law is that international interference, as accordingly with the UN charter, can be justified if it is for the sake of democracy or protection of human rights. United States' justification for drone strikes is that the strikes are for the protection of its own citizens and are being used for self-defense (Cohen, 2014). This makes the strikes legitimate under international law. However, more countries are asking for better transparency and civilian deaths are raising suspicions regarding the drone program. This is the prime reason that the United Nations have started to look into the matter and investigations regarding civilian deaths are ongoing.

**War on Terror**

After the attacks on the World Trade Center in New York on September 11, 2001, the Bush administration launched the War on Terrorism. Even in the past, America has declared war on objects and ideas such as drugs and poverty. President Lyndon Johnson declared War on Poverty in 1964 and War on Drugs was declared by President Nixon in 1971 (PBS, 2014). So the terminology, “War on Terror”, is not surprising especially when it is coming from America.

War on Terror is a global war and involves other countries other than the United States. According to *Global Policy Forum*:

> After the terrorist attacks of September 11, 2001, the Bush administration declared a worldwide ‘[W]ar on [T]error,’ involving open and covert military operations, new security legislation, efforts to block the financing of terrorism, and more. Washington [DC] called on other states to join in the fight against terrorism asserting that either you are with us, or you are with the terrorists. Many governments joined this campaign, often adopting harsh new laws, lifting long-standing legal protections and stepping up domestic policing and intelligence work (Global Policy Forum, 2014).

Apart from United States, many other NATO and non NATO nations participate in the conflict. The UK, France, Germany and Pakistan are some of the most active participants in the War on Terror.

The War on Terror is not being fought against one country or entity. This war resulted in United States’ invasion of countries like Iraq and Afghanistan. American and NATO troops invaded Afghanistan in 2001 in an attempt to defeat Al-Qaeda, a Non-Government Organization (NGO) suspected to be involved in the 9/11 attacks. In 2003, the troops invaded Iraq under the impression that Iraqi president, Saddam Hussein, had weapons of mass destruction to support terrorist networks. On the other hand, the US is also carrying out small operations and targeted killings in Yemen and tribal parts of Pakistan through drone strikes. Richard Jackson, a political theorist, has argued, “the 'war on terrorism', is simultaneously a set of actual practices—wars, covert operations, agencies, and institutions—and an accompanying series of assumptions, beliefs, justifications, and narratives—it is an entire language or discourse” (2005). Invasions, operations and drone strikes in different countries make this war different and unique from a traditional war. It is evident that perimeter of this war surpasses the borders of different countries.

Predator drones came into the limelight across the world due to the War on Terror. The United States have been using drones to target key elements in Afghanistan, Somalia, Yemen, and tribal regions of Pakistan. Michael G. Vickers, Undersecretary of Defense for Intelligence, claimed that:

> Unmanned missile-firing aircraft, along with intelligence collectors and targeters, are key elements in the U.S. counterterrorism strategy and operations and will remain a top priority for the next 12 years. Drone attacks have been the most precise campaign in the history of warfare (Gertz, 2013).

Advantages of drones are very prominent and well known over traditional weapons in Afghanistan and Pakistan. The regions are mountainous with rough topography and provide very good hiding places for militants. Drones are very effective in targeting militants in those almost inaccessible areas. Other than that, striking from a drone costs less money and soldiers than action taken by troops at land and it does not put the pilot under any risk. According to a report by *Council on Foreign Relations*:

> They [drones] can silently observe an individual, group, or location for hours on end, but take immediate action should a strike opportunity become available--all without putting a pilot at risk. This combination of capabilities is unique and has allowed the United States to decimate the leadership of al-Qaeda in Afghanistan and disrupt the activities of many other militant groups (Zenko & Fellow, 2013).

Drones, therefore, are extensively being used and form an integral part of this war due to their benefits and effectiveness.

**Limiting Drone Use**

Drones have emerged as leading weapons in America's War on Terror. Invading all countries with terrorist networks would have resulted in large military spending but drones provide the United States with a very good alternative to invading countries and actual military actions. This is one of the reasons that they have been significantly used by the United States in targeting key militants in Yemen, Somalia and tribal regions of Pakistan. *Procon.org* further states:

> ...drones make US military personnel safer. Drones are launched from bases in allied countries and are operated remotely by pilots in the United States, minimizing the risk of injury and death that would occur if ground soldiers and airplane pilots were used instead (Procon, 2014).

In comparison, drones are much less destructive than nuclear and biological weapons and therefore can be used for precise and targeted operations in populated areas.

The effectiveness and usefulness of a drone will prompt an arms race where more countries would want to have drones in their arsenal. One example is the Canadian military which is spending $1 Billion on unmanned armed drones. It is apparent that Canada is getting involved in the drone arms race (Radia, 2012). In spite of all these benefits, it does not go without saying that drones present a lot of drawbacks. The strikes result in collateral damage in the affected areas. A strike is totally dependent on intelligence information and a slight error can result in wrong or innocent target being killed. In one of the reports by *Council on Foreign Relations,* Micah Zenko writes:

> ...drones are not without their drawbacks, especially with regard to targeted killings. Like any tool, drones are only as useful as the information guiding them, and for this they are heavily reliant on local military and intelligence cooperation. More important, significant questions exist about who constitutes a legitimate target and under what circumstances it is acceptable to strike (2013).

A report titled *Reaching Critical Will* emphasized that “the progress of science and technology could make it necessary to strengthen the existing international legal system” (The Women’s International League for Peace and Freedom, 2013). As drones become popular and more countries begin to acquire this technology, the United Nations should consider putting strict laws regarding drone use. Widespread use of drones without proper restrictions in place will create global complications.

Imagine a scenario in which India starts to strike regions of Pakistan with drones, targeting elements it does not like or vice versa. The US is already involved in targeting militants in the tribal regions and this can encourage India to follow. Similarly, China can also use drone strikes in Vietnam. The US would not have the credibility and morality to prevent such a drone war because it is already using drones to do the same thing and admitting the responsibility of the attacks as well. According to the report, The Downside of Drones, “The chief legal drawback to drone use is not international law, per se, but rather the threat of copycats that the U.S. government will have little practical or moral grounds for opposing” (Robinson, 2013). This can be problematic in terms of stability in the respective regions.

At the moment, there are no clear laws limiting international use of drones. There have been several debates in the United Nations, but a firm stance is yet to come. The United Nations can put forward a treaty, such as nuclear nonproliferation treaty whose goal is nuclear disarmament, to limit international drone use. Such a treaty can prevent more countries form using drones as weapons.

Other than being used for strikes and targeting militants, drones can also be used for surveillance. Domestic surveillance is covered earlier in this paper. Apart from that, drones can also be used for international surveillance. As drones are comparable to traditional aircrafts, similar laws can also be applied to drones' flight over the international airspace. Air sovereignty, as specified in the Chicago Convention of 1944, "is the fundamental right of a sovereign state to regulate the use of its airspace and enforce its own aviation law - in extremis by the use of fighter aircraft" ("Chicago Convention", 1946). International surveillance for protection and peacekeeping purposes is justified. The United Nations started using drones for border patrol in Congo to monitor the border with Uganda and Rwanda where both countries were accused of aiding the rebels in eastern Congo by UN experts. Drone surveillance can help in settling the dispute amongst the three countries by providing reliable information (Katombe, 2013).

International surveillance, on the other hand, can also fall into the category of espionage if done secretly or without the consent of the host country. Espionage, as defined by Merriam Webster, is "the practice of spying or using spies to obtain information about the plans and activities especially of a foreign government" (Merriam-Webster, 2014). It is understandable that most countries would have reservations with foreign drones flying overhead and carrying out surveillance. Consequently, these drones will raise suspicions of spying and data collection by another country. This can be compared to the U2 incident in 1960 when the Soviet government caught an American aircraft over its airspace. The US had to admit aircraft's role as covert surveillance when the pilot was captured and convicted of espionage. However, in the case of drones, it is difficult to track its origin or who commands it. If a drone is captured while doing covert surveillance, any country can deny its involvement. Technical complications will make it almost impossible to track the original route of a drone. General Inspector Calvin Scovel II, Department of Transportation, claimed that, "air-traffic controllers are reporting that current systems are not adequate to keep track of drones, let alone keep them separate from manned aircraft" (Fitzgerald, 2014). Even after that, other complications can occur when one country uses another country's air base. These complications, as a result, are delaying the timely implementation of laws regarding drones.

RPAs used for international surveillance can create a global confusion in terms of responsibility for the crime. Jennifer Gibson, in a personal interview, said, "Lack of transparency in drone program makes it controversial to execute. Any country can start using drones and act like US. It is about setting a standard" (J. Gibson, personal communication, March 10, 2014). If drones' use as a weapon and a tool for surveillance in non-war zones can be reduced, this can be effective in terms of improving drone's negative image in the general public. One example is the Canadian drone program where Canada is looking for a more productive utility. They have intentions of using unmanned vehicles for maritime and arctic patrols and are planning to use predator drones only in the war zones (Campion-Smith, 2013). Drones are also used for search and rescue missions, forest fire preventions, border patrol, and transportation. It is evident that drones have some very useful benefits if used within legal guidelines.

**Legal Systems**

US drone strikes in Pakistan and Yemen result in hundreds of civilian casualties, as discussed in the earlier part of the paper. A drone strike caused several deaths at a wedding in Yemen (Almasmari, 2013). Furthermore, a drone killed 40 members of a Wazir tribal Jirga on March 17, 2011 (Akbar, 2012). As drone strikes rely completely on intelligence information, any slight error in the communication will change the intended target. In populated areas and non-war zones like the tribal regions of Pakistan, a small error in target can result in dozens of civilian deaths. All civilian deaths, where no high level militants are killed can be seen as intelligence failures. So intelligence officers, rather than drone operators, are responsible for any of the wrong targets hit by a drone strike. In spite of the civilian casualties by drone strikes, no one has been convicted or punished by the authorities or international courts. Innocent killings in non-war zones are similar to people being killed in a territory by foreign forces. Killing people on suspicion is just like a death penalty without a proper court trial but killing civilians in such numbers in non-war zones is completely unacceptable and the responsible people should be held accountable for those unjust killings.

It is important to mention the case put up by the parents of three United States' citizens who were killed in US drone strikes without proper trial. Anwar al-Awlaki was targeted by Obama Administration on 30$^{th}$ September, 2011 in a drone strike in Yemen. His 16 year old son, Abdul Rahman al-Awlaki, was killed two weeks later by a drone strike too. After this attack, Obama was "surprised, upset and wanted an explanation . . . one former White House official calls [this attack] a mistake, a bad mistake" (Siddiqui, 2013). The US government, however, is confident that it can kill US citizens without trial if they are involved in an activity against state. Attorney General, Eric H. Holder Jr.:

> ...asserted on Monday that it is lawful for the government to kill American citizens if officials deem them to be operational leaders of Al Qaeda who are planning attacks on the United States and if capturing them alive is not feasible (Mataconis 2012).

The question is what about the deaths caused by drone attacks such as of Abdul Rahman al-awlaki if they are declared an accident by US authorities. No one was convicted for this 'bad mistake' when the judge, Rosemary M. Collyer of Federal District Court for the District of Columbia, dismissed the suit and refused to hold the top US officials directly responsible for the crimes. Baher Azmy, the center's legal director, criticized the decision and said, "The Constitution cannot permit the killing of U.S. citizens based on the government's untested claim of dangerousness" (Savage, 2014).

It is unfortunate that the officials are not being held responsible by the courts for making mistakes and killing civilians in Pakistan and Yemen. Charlie Savage writes in the same article:

> If it stands, the ruling suggests that courts have no role to play, before or after, in reviewing the legality of government decisions to kill citizens whom officials deem to be terrorists in overseas wartime operations, even away from "hot" battlefields where conventional American forces are on the ground (2014).

In response to mismanaged operations, US government imposed a temporary ban on the Pentagon's armed drones flying over Yemen, launched from an American base in Djibouti. (Mazzetti, 2014). However, the Central Intelligence Agency's (CIA) drone war still continues in Yemen. CIA's director at that time, John O Brennan, said a year ago that "it was time to refocus an agency that had become largely a paramilitary organization after the Sept. 11 attacks toward more traditional roles carrying out espionage, intelligence collection and analysis" (Mazzetti, 2014). But the CIA has not been convicted of any of the civilian killings in Yemen or Pakistan. Emphasizing again that these areas are not at war, this is an offense that the officials should be held accountable. Jennifer Gibson remarked:

> White House should be held accountable for all the unfair civilian killings in Pakistan. All the decisions come from the White House and Obama should claim the responsibility of these killings at places where a war is not going on. International Courts should take an initiative and hold the authorities responsible (J. Gibson, personal communication, March 10, 2014).

Accountability of the guilty and better transparency will help remove stigma from international drone use.

**How to Fight Non-State Actors**

United States has been using troops to target the non-state actors and key militants in Afghanistan. The NATO and US forces have been vigorously involved in field battles which have resulted in huge number of casualties from both sides. As of April 4, 2013, according to Defenselink Casualty Report, 2,178 US military deaths have occurred in Afghanistan only and 19,964 American service members have been wounded during the war (2014). On the other hand, using drones to target militant factors and non-state actors in Afghanistan, neighboring country Pakistan and Yemen have resulted in death of none of the American troops. Hence, the US has expanded the role of predator drones recently in the Afghan battlefield. According to an article, Drones Are Playing a Growing Role in Afghanistan:

> The use of the drones has expanded quickly and virtually unnoticed in Afghanistan. The Air Force now flies at least 20 Predator drones — twice as many as a year ago — over vast stretches of hostile Afghan territory each day. They are mostly used for surveillance, but have also carried out more than 200 missile and bomb strikes over the last year . . . in Afghanistan, a country with nearly 70,000 American troops, the drones have stealthily settled into an everyday role (Drew, 2010).

Drone strikes in a war zone such as Afghanistan are appropriate because drones create safer environment for military troops on the field and strike the militants hiding in the mountains and other inaccessible areas. In a war zone, drones are just another form of weapon such as military jets dropping missiles and bombs on the opposition forces.

However, drones used in non-war zone territories to target non state actors and militants clearly violate the sovereignty of the state. Non-state actors, as defined by Stockholm International Peace Research Institute, “include, but are not necessarily limited to, rebel opposition groups, local militias and warlords, as well as vigilante and civil defense groups, when such are clearly operating without state control" (2009). In a personal interview, Jennifer Gibson, said:

> Drones are not illegal if used in a war zone. It is just another sort of a weapon. However, the problem is when the US uses drones in Pakistan and Yemen because US is not at war with these countries and consequently, they are not war declared zones. Drones are not the answer to everything . . . drones are becoming the only tool and hence getting counter-productive. Drones should only be used in extreme cases and UN Security Council should have a say in that decision (J. Gibson, personal communication, March 10, 2014).

Keeping in mind the advantage drones have over traditional warfare, it can be argued that targeting the non-state actors is only going to get tougher if we limit drone use. It is interesting to see that the US is more concerned for Russia undermining Ukraine's sovereignty where, on the other hand, it itself is responsible for violating sovereignties of several states (Vinik, 2014). This is where United Nations Security Council has a crucial role to play. According to the following agenda of the Security Council, the council should take complete responsibility for settling this dispute.

> Under the Charter, the Security Council has primary responsibility for the maintenance of international peace and security. It has 15 Members, and each Member has one vote. Under the Charter, all Member States are obligated to comply with Council decisions. The Security Council takes the lead in determining the existence of a threat to the peace or act of aggression. It calls upon the parties to a dispute to settle it by peaceful means and recommends methods of adjustment or terms of settlement. In some cases, the Security Council can resort to imposing sanctions or even authorize the use of force to maintain or restore international peace and security (United Nations, 2014).

To avoid this confusion of disputing sovereignty, the Security Council can formulate a list of key non-state actors and militants that need to be eliminated. First responsibility should be given to the host country to eliminate them in their own territory using its own armed forces. For instance, Pakistan should be given the charge of targeting the militants in the tribal regions. In 2009, the Pakistan army fought a battle with the Taliban to gain control of the Swat region. The operation was slow because the army was avoiding civilian casualties but turned out to be successful in the end when Pakistan claimed the upper hand in several key places (Wilkinson, 2009).

However, two cases are possible in this regard. Sometimes the militants are too strong and widespread that it is not possible for the home country to eradicate all of them. The second possibility is that the country might be harboring terrorist and militants secretly. In such cases, a general “wanted” list can be issued by the UN Security Council where any country such as the US with resources and technology like predator drones can take action and target those militants irrespective of their location. This would not be considered as a violation of the sovereignty due to two main reasons. First is that the action is taken with the consent of the home country (in the scenario in which country agreed to get foreign help) and second is that the target was specified by the Security Council, a global peacekeeping organization. If these standards and regulations are followed, predator drones can be very effective on foreign soil without violating sovereignties of other countries.

**Implications of Law**

Apart from the countries getting affected by drone strikes, other countries are also calling for greater transparency in the drone program by the United States and allies.

> Key members of the United Nations – including some of Washington's closest allies – broke with a decade of tradition . . . when they endorsed calls for greater transparency over drone civilian deaths. The European Union, the United Kingdom and Switzerland were joined by the Russian Federation and China in calling for greater openness from those carrying out drone strikes. Pakistan was particularly strident, insisting that there was 'no implicit or explicit consent' for US drone strikes on its territory, which it insists have a 'disastrous humanitarian impact' (Woods, 2013).

Even though drones are not illegal according to UN charter discussed earlier, their misuse can certainly be questioned by countries around the globe. The main concern of the UN is not the law, rather it is the civilian deaths and improper use of drone strikes. Professor Christof Heyns, UN expert on extrajudicial killings said, "Armed drones are not illegal, but as lethal weapons they may be easily abused and lead to unlawful loss of life, if used inappropriately" (Woods, 2013).

The United Nations should consider all the reports on drone strikes and formulate laws to put a halt to growing inappropriate drone use. Keeping in mind the number of countries supporting better and transparent drone use, it would not be tough to come up with regulations acceptable globally. The United Nations, being the supreme authority for international cooperation, should have the complete authority to making tighter regulations where there is more transparency and accountability for improper drone strikes. The UN presently has legal and human rights experts investigating civilian casualties and inappropriate drone use. "[Ben] Emmerson has been investigating the use of armed drones for 14 months. His report examined 37 drone strikes where there are reports of civilian casualties" (Serle 2014). Currently the statistics on civilian casualties in drone strikes are very vague. As stated earlier in the paper, civilian casualty numbers from US officials contradict with the numbers of different humanitarian organizations. However, it would not be long until the United Nations would have all the data available from its special investigators which they can rely on. The data can then be used for further rulings on predator drones in other countries.

The rulings by the UN should be acceptable to all the states. Once the laws are put into place, the next step will be to enforce them onto the states and making sure that the laws are being followed across the globe. For states which are not willing to accept the new rules, United Nations can use different approaches to enforce its laws. One approach can be international pressure. International pressure can be very effective in order to make a state do something it does not like. As the state is not interested in getting internationally isolated, there are chances that it would succumb to international pressure. Another approach can be to apply an economic sanction which is described in The Merriam-Webster Dictionary as a "coercive measure adopted usually by several nations in concert for forcing a nation violating international law to desist or yield to adjudication " (Merriam-Webster, 2014). Economic sanctions have been very effective in the past; one example is when sanctions on Iran forced it to put off its nuclear program temporarily. "Seeking to avoid sanctions in the U.N. Security Council, Iran began negotiations with Britain, France, and Germany . . . and agreed to temporarily suspend activities related to uranium conversion and enrichment" (Christy & Zarate 2014). However, drafting inflexible, neutral and acceptable laws would be a good step to take for the UN at the moment.

**Conclusion**

It is apparent that drones are not entirely illegal but objections are raised when drones become the cause of civilian deaths in war zones and more importantly, non-war zones. Drone technology has huge potential and it can go a long way to benefit humans. Even if the use of military drones is reduced, there are still many ways where drone can help immensely. If international surveillance can create problems, domestic surveillance and surveillance by the United Nations to look after troubled borders can be very useful. In the presence of fair and strict regulations, drone technology can grow and further revolutionize the way things are done.

## Summary

In summation, drones, or UAVs, are a diverse group of machines. This means there should be a clear system of classification based on altitude for domestic UAVs and classes based on use for military use. UAVs should also be referred to as RPAs because this is a better description of what they do and what they are. While RPAs are characterized by their sensors, controller, and communication device, there are problems with this system. These issues can be fixed by introducing autonomous systems to help hover or land the RPA when connection is lost or the battery is almost dead. Another issue that needs to be addressed is the public dislike of RPAs, but this will be resolved by the integration of RPAs into the economy. While there is no current solution to the short battery life plaguing RPAs, there is promising innovation in the field of portable power storage. The future will also contain less traditional RPA designs because they will no longer be made with a human pilot in mind.

The safety of human pilots in other aircraft is a major concern for the FAA as they attempt to fulfill all of the Congressionally mandated tasks outlined in the FAA Modernization Reform Act of 2012 (FMRA). The FAA has struggled to meet any of its deadlines despite the fact that they had begun to take notice of RPAs at least five years before FMRA was passed. The FAA is far behind schedule for achieving RPA integration into the NAS (National Air Space) which, in turn, delayed the possible economic benefits from the use of RPAs in industries like agriculture. The application of RPAs to such fields could provide huge benefits not only to America but also across the globe. However, even if the FAA achieves all of its goals on time, there is still the large issue of privacy that needs to be dealt with. Congress has remained silent on the issue and the FAA has announced it will not create any RPA privacy regulations. This lack of guidance will cause further delays after the FAA issues its final rulings, as privacy will be decided through a series of court cases. Small RPAs need to have established rules set in place regarding both safety and privacy in order to allow the economic benefits of RPA integration. These economic benefits are valuable enough to merit Congressional attention to help settle national issues like privacy, and to help accelerate the FAA's progress.

The United States of America has used RPAs, or drones, as part of its military in the War on Terror. The majority of the publics from the USA, Israel and Kenya view the United States' international drone program positively, while the majority of the rest of the world hold negative opinions regarding drones. This unpopularity can be attributed to: their concerns about morality, civilian casualties, rise in militancy, and nonobservance of human rights and a lack of mindfulness of international humanitarian laws in regard to drone strikes. Although these strikes have killed numerous Al Qaeda and Taliban leaders, the moral concern is over the power this technology grants to a select few.

Even though the US government claims, due to the technology's precision, that there are little or no civilian casualties caused by drone strikes, humanitarian organizations and critics of drones argue that these attacks result in significant casualties. Several cases of civilian casualties that include women and children have been noted and investigated in Afghanistan, Pakistan and Yemen. It is also argued that due to these civilian casualties and violations of international humanitarian laws, individuals in the affected areas are more likely to join the ranks of terrorist organizations, giving rise to militancy. It is then necessary that the American drone program should adhere to the Universal Declaration of Human Rights as well as the International Humanitarian Law both inside and outside a war zone. Specifically, drone attacks outside a war zone should be reduced or halted and a better alternative of negotiations and dialogue with local leaders should be adopted. This is the best way to comply with not only humanitarian laws, but also avoid a future where international assassination becomes as easy as pressing a button.

Drone strikes present a lot of benefits when compared to traditional warfare, but recently more countries are raising concerns about these programs. These concerns include issues like the possible violations of national sovereignty, the continued loss of civilian lives, and less transparency of drone strikes in non-war zones. The United Nations, after completing its ongoing investigation, should ratify proper legislations and rulings regarding international RPA use. This is the only way to address different issues regarding military RPAs and prevent their further improper use. Once the UN passes fair and acceptable legislation and ensures its implementation, the world will benefit immensely from this valuable technology.

## References

3D Robotics. (2014). Autopilots. Retrieved from 3D Robotics: http://store.3drobotics.com/t/parts/autopilots

5 U.S. Code Section 553 - Rule making. (2014). Retrieved from Legal Information Institute: http://www.law.cornell.edu/uscode/text/5/553

18 U.S Code Section 32 - Destruction of aircraft or aircraft facilities. (2014). Retrieved from Legal Information Institute: http://www.law.cornell.edu/uscode/text/18/32

A bird's eye view of Haiyan devastation. (2013). CNN. Retrieved from http://cnnpressroom.blogs.cnn.com/2013/11/18/cnn-uses-drone-camera-for-aerial-view-of-tacloban/

Abé, N. (2012, December 14). Dreams in Infrared: The Woes of an American Drone Operator. Retrieved from Spiegel Online International: http://www.spiegel.de/international/world/pain-continues-after-war-for-american-drone-pilot-a-872726.html

Aeronautics and Space, 14 C.F.R. pt 11 (2014)

AFS-80. (2013, January 1). N 8900.207. Retrieved from Unmanned Aircraft Systems (UAS) Operational Approval: http://www.faa.gov/regulations_policies/orders_notices/index.cfm/go/document.information/documentID/1020678

Akbar, M. S. (2012, October 4). The folly of drone attacks and U.S. strategy. CNN. Retrieved from: http://www.cnn.com/2012/10/04/opinion/pakistan-drone-attacks-akbar/

Ali, M. A. (n.d.). Islam, Jihad, and Terrorism. About Jihad. Retrieved April 26, 2014, from: http://www.aboutjihad.com/terrorism/islam_jihad_terrorism.php

Ali, Y. A. (2013, August 6). Understanding Pashtunwali. The Nation. Retrieved from: http://www.nation.com.pk/columns/06-Aug-2013/understanding-pashtunwali

Almasmari, H. (2013, December 13). Yemen says U.S. drone struck a wedding convoy, killing 14. CNN. Retrieved from: http://www.cnn.com/2013/12/12/world/meast/yemen-u-s-drone-wedding/

Amazon Reports Surging Holiday Sales. (2013, December 27). Retrieved from New York Post: http://nypost.com/2013/12/27/amazon-reports-surging-holiday-sales/

Annexation. (2014). In Encyclopædia Britannica online. Retrieved from http://www.britannica.com/EBchecked/topic/26334/annexation

Anyone killed by US is a 'martyr': Fazlur Rehman. (2013, November 5). The Express Tribune. Retrieved from: http://tribune.com.pk/story/627393/anyone-killed-by-us-is-a-martyr-fazlur-rehman/

Arjomandi, M. (2006). Classification of Unmanned Aerial Vehicles. Retrieved from the University of Adelaide: http://personal.mecheng.adelaide.edu.au/maziar.arjomandi/Aeronautical%20Engineering%20Projects/2006/group9.pdf

B3A. (2014). Total of Crashes. Retrieved from Bureau of Aircraft Accidents Archives: http://www.baaa-acro.com/advanced-search-result/?type=crash&display=entry&year_post=2013&continent=0&country=0&pavillon=0&aircraft=0&operator=0&cause=0&et_searchform_submit=et_search_proccess

Baglole, J. (2014). MQ-1 Predator - Unmanned Aerial Vehicle. Retrieved from About: http://usmilitary.about.com/od/uavs/a/mq1.htm

Becker, J., & Shane, S. (2012, May 29). Secret ‘Kill List’ Proves a Test of Obama’s Principles and Will. The New York Times. Retrieved from: http://www.nytimes.com/2012/05/29/world/obamas-leadership-in-war-on-al-qaeda.html?pagewanted=3&_r=0

Benefits. (2014). Retrieved from CropCam: http://cropcam.com/products.htm

Bergen, P., Doherty, P. C., & Ballen, K. (2010, September 28). Public Opinion in Pakistan’s Tribal Regions. The New America Foundation. Retrieved from: http://newamerica.net/publications/policy/public_opinion_in_pakistan_s_tribal_regions

Bezos, J., & Clark, D. (2013, December 1). Amazon's Jeff Bezos Looks to the Future. (C. Rose, Interviewer)

Blackhurst, R. (2012, September 24). The air force men who fly drones in Afghanistan by remote control. Retrieved from The Telegraph: http://www.telegraph.co.uk/news/uknews/defence/9552547/The-air-force-men-who-fly-drones-in-Afghanistan-by-remote-control.html

Brennan Center for Justice (2013, April 23). Addressing the Privacy Implications of the Domestic Use of Unmanned Aerial Vehicles. New York, New York

Brown, A., & Newport, F. (2013, March 25). In U.S., 65% Support Drone Attacks on Terrorists Abroad. Gallup Politics. Retrieved from: http://www.gallup.com/poll/161474/support-drone-attacks-terrorists-abroad.aspx

Brown, G., Harris, W. (2000, May 19) How Satellites Work. Retrieved April 08, 2014 from how stuff works: http://science.howstuffworks.com/satellite7.htm

Brown Express Inc. v. U.S., 79-1457 (5th Circuit November 30, 1979).

Build Your Own Drone. (2013). BYOD. Retrieved from Build Your Own Drone website: http://www.buildyourowndrone.co.uk/

Byman, D. L. (2013, July/August). Brookings Research Articles. Brookings. Retrieved from: http://www.brookings.edu/research/articles/2013/06/17-drones-obama-weapon-choice-us-counterterrorism-byman

Campion-Smith, B. (2013, March 25). Canada's air force eyes drones for maritime and Arctic patrols. thestar.com. Retrieved April 19, 2014, from http://www.thestar.com/news/canada/2013/03/25/canadas_air_force_eyes_drones_for_maritime_and_arctic_patrols.html

Carbon nanotubes. (2014). Retrieved from Nanocyl: http://www.nanocyl.com/en/CNT-Expertise-Centre/Carbon-Nanotubes

Carjacking/Vehicular Hijacking. (2010). Retrieved April 2014, from The Legal Defenders, P.C.: http://www.legaldefenderspc.com/practice/carjacking_hijacking.html

Carey, B. (2014, March 07). Judge Rules Against FAA in 'Landmark' UAV Challenge. Retrieved from AIN Online: http://www.ainonline.com/aviation-news/2014-03-07/judge-rules-against-faa-landmark-uav-challenge

Carroll, J. (2014). The future is here: Five applications of UAV technology. Retrieved from Vision Systems: http://www.vision-systems.com/articles/2013/12/the-future-is-here-five-applications-of-uav-technology.html

Carroll, R. (2012, August 2). The philosopher making the moral case for US drones. The Guardian. Retrieved from: http://www.theguardian.com/world/2012/aug/02/philosopher-moral-case-drones

Carroll, R. (2014, January 28). US border patrol drone crashes off California coast. The Guardian. Retrieved from: http://www.theguardian.com/world/2014/jan/28/us-border-patrol-drone-crashes-california-mexico

Casualty Status. (2014, April 4). US Department of Defense. Retrieved April 20, 2014, from http://www.defense.gov/news/casualty.pdf

Chapter 1. Attitudes toward the United States. (2013, July 18). Pew Research Global Attitudes Project. Retrieved from: http://www.pewglobal.org/2013/07/18/chapter-1-attitudes-toward-the-united-states/

Chow, D. (2013, November 5). Drone Wars: Pilots Reveal Debilitating Stress Beyond Virtual Battlefield. Retrieved from livescience: http://www.livescience.com/40959-military-drone-war-psychology.html

Ching-Ching, H. (2013, October 05). US to deploy Global Hawk surveillance drones in Japan. Retrieved from Want China Times: http://www.wantchinatimes.com/news-subclass-cnt.aspx?id=20131005000060&cid=1101

Christy, P. & Zarate, R. (2014, March 17). FPI Fact Sheet: Timeline on Diplomacy and Pressure on Iran's Nuclear Program. The Foreign Policy Initiative. Retrieved April 21, 2014, from http://www.foreignpolicyi.org/content/timeline-diplomacy-and-pressure-irans-nuclear-program

Cohen, T. (2014, February 11). When can a government kill its own people?. CNN Politics. Retrieved April 20, 2014, from http://www.cnn.com/2014/02/10/politics/us-killing-americans/

Cohen v. Cowles Media Co. (1992, January 24). Retrieved from Leagle: http://www.leagle.com/decision/1992866479NW2d387_1848.xml/COHEN%20v.%20COWLES%20MEDIA%20CO

Constine, J., Perez, S. (2014, March 03). Facebook Looking into Buying Drone Maker Titan Aerospace. Retrieved March 08, 2014 from Techcrunch: http://techcrunch.com/2014/03/03/facebook-in-talks-to-acquire-drone-maker-titan-aerospace/

Continued Support for U.S. Drone Strikes. (2013, Febuary 11). Retrieved from PewResearch: http://www.people-press.org/2013/02/11/continued-support-for-u-s-drone-strikes/

Corbett, P. (2014, January 27). Commercial Use of Unmanned Aerial Vehicles Growing. Retrieved from Claims Journal: http://www.claimsjournal.com/news/west/2014/01/27/243441.htm

Corcoran, M., Goldberg, D., & Picard, R. G. (2013). Remotely Piloted Aircraft Systems & Journalism. Reuters Institute for the Study of Journalism.

Covert, A. (2008, May 29). World's Smallest UAV Weighs 10 Grams, Flaps Like a Bird. Retrieved from Gizmodo: http://gizmodo.com/394155/worlds-smallest-uav-weighs-10-grams-flaps-like-a-bird

Crump, C., & Stanley, J. (2011). Protecting Privacy From Aerial Surveillance: Recommendations for Government Use of Drone Aircraft. New York: American Civil Liberties Union.

Cummings, M. (2013, December 2). Amazon's drone delivery: How would it work? (D. Gross, Interviewer)

Dillingham, G. L. (2013, February 15). Continued Coordination, Operational Data, and Performance Standards Needed to Guide Research and Development. Unmanned Aircraft Systems. United States Government Accountability Office.

Dillingham, G. L. (2014, February 5). Progress and Challenges Implementing Various Provisions of the 2012 Act. FAA REAUTHORIZATION ACT. United States Government Accountability Office.

Dixon, D. (2010, June 22). Carbon Nanotubes Boost Power of Lithium Battery. Retrieved from Scientific American: http://www.scientificamerican.com/article/carbon-nanotubes-boost-power-of-lithium-battery/

Dolan, A. M., & Thomson II, R. M. (2013). Integration of Drones into Domestic Airspace: Selected Legal Issues. Congressional Research Service.

Dopp v. Fairfax Consultants, LTD. (1990, November 16). Retrieved from Leagle: http://www.leagle.com/decision/19901265771FSupp494_11157

Draganflyer X6. (2014). Retrieved from DraganFly: http://www.draganfly.com/uav-helicopter/draganflyer-x6a/index.php

Drone issue may give rise to Pak-US conflict. (2013, July 4). Retrieved December 15, 2013, from http://www.geo.tv/article-107988-Drone-issue-may-give-rise-to-Pak-US-conflict

Drone. (2014). In oxforddictionaries.com. Retrieved December 19, 2013, from http://www.oxforddictionaries.com/us/definition/american_english/drone

Drones. (2014, April 10). Retrieved from http://drones.procon.org/

Drone strikes in Pakistan. (2014). The Bureau of Investigative Journalism. Retrieved March 28, 2014, from: http://www.thebureauinvestigates.com/category/projects/drones/drones-pakistan/

Drone strikes in Yemen. (2014). The Bureau of Investigative Journalism. Retrieved March 28, 2014, from: http://www.thebureauinvestigates.com/category/projects/drones/drones-yemen/

Dworkin, A. (2012, June 19). Obama's Drone Attacks: How the EU Should Respond. European Council on Foreign Relations. Retrieved from: http://ecfr.eu/content/entry/commentary_obamas_drone_attacks_how_the_eu_should_respond

Economic Research Service and Foreign Agricultural Service. (2013, August 29). Outlook for U.S. Agricultural Trade.

Electric RC. (2011, December 19). Draganflyer-X6. Retrieved from Electric RC Helicopter Reviews: http://electricrchelicopterreviews.com/draganflyer-x6/

Elliott, J. (2012, June 18). Obama Administration's Drone Death Figures Don't Add Up. ProPublica. Retrieved from: http://www.propublica.org/article/obama-drone-death-figures-dont-add-up

Epatko, L. (2013,,April 18). How Are Drones Used in the U.S.? PBS. Retrieved from http://www.pbs.org/newshour/rundown/how-are-drones-used-in-us/

Espionage. (2014). In Merriam-Webster.com. Retrieved April 15, 2014, from http://www.merriam-webster.com/dictionary/espionage

Eyeman, J., Letterman, C., Pitts, W., Hinkle, K., Schanzer, D., … Kaydos-Daniels, S. C. (2013, June). Unmanned Aircraft and the Human Element: Public Perceptions and First Responder Concerns. Retrieved from Institute for Homeland Security Solutions: http://sites.duke.edu/ihss/files/2013/06/UAS-Research-Brief.pdf

FAA UAS Online Listening Session. (2013, April 3). Retrieved from Federal Aviation Administration: http://www.faa.gov/about/initiatives/uas/media/UAStranscription.pdf

Fact Sheet. (2013, January). Freedom from Drone Surveillance Resolution. The Rutherford Institute.

Federal Aviation Administration. (1981, June 9). Advisory Circular. Retrieved from Federal Aviation Administration: http://www.faa.gov/documentLibrary/media/Advisory_Circular/91-57.pdf

Federal Aviation Administration. (2011). Destination 2025.

Federal Aviation Administration. (2012, May 14). FAA Makes Progress with UAS Integration. Retrieved from Federal Aviation Administration: www.faa.gov/news/updates/?nesId=68004

Federal Aviation Administration. (2013, February 22). Final Privacy Requirements. Washington D.C., United States: Federal Register.

Federal Aviation Administration. (2014, March 17). GPS Accuracy. Retrieved from GPS: http://www.gps.gov/systems/gps/performance/accuracy/

Federal Aviation Administration. (2013). Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap.

Federal Aviation Administration v. Raphael Pirker, CP-217 (National Transportation Safety Board Office of Administrative Law Judges September 27, 2013).

Federal Aviation Administration; UAS Aviation Rulemaking Committee. (2013). Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap.

Ferner, M. (2013, December 2). Drone Hunting Practice Begins in Colorado Town. Retrieved from Huff Post Politics: http://www.huffingtonpost.com/2013/12/02/drone-hunting-shooting_n_4372769.html

Fisk, K., Merolla, J., Ramos, J., & Zechmeister, E. (2013, May 28). Terrorism Threat Elevates Public Support for Drones. The Huffington Post. Retrieved from: http://www.huffingtonpost.com/jennifer-merolla-phd/public-opinion-drones_b_3340280.html

Fitzgerald, S. (2014, February 6). FAA: Drone Flight Approvals Not Likely For Years. Newsmax. Retrieved April 22, 2014, from http://www.newsmax.com/US/faa-drone-flights/2014/02/06/id/551284/

Franchi, P. L. (2006, June 13) US FAA Studies Three-Category UAV Classification and Certification System for Integration into Civil Airspace. Retrieved from Flightglobal: http://www.flightglobal.com/news/articles/us-faa-studies-three-category-uav-classification-and-certification-system-for-integration-into-207171/

Frou Frugal. (2014). Guy Gift Ideas. Retrieved from Frou Frugal: http://www.froufrugal.com/2013/06/guy-gift-ideas/

Fung, K. (2013, August 26). Drone Recording Virginia Bull Run Crashes Into Crowd. Retrieved from Huffington Post: http://www.huffingtonpost.com/2013/08/26/drone-tv-bull-run-crash_n_3816600.html

Georacer. (2013, May 23). Altitude Comparison: barometer vs GPS. Retrieved from DIYDrones: http://diydrones.com/profiles/blogs/altitude-comparison-barometer-vs-gps

Gerges, F. (2013, June 21). Why drone strikes are real enemy in 'war on terror'?  CNN Opinion. Retrieved from CNN: http://www.cnn.com/2013/06/21/opinion/terrorism-gerges/

Gertz, B. (2013). Pentagon: Drone strikes to remain indispensable weapon against terrorists. The Washington Free Beacon, Retrieved from http://freebeacon.com/national-security/pentagon-drone-strikes-to-remain-indispensable-weapon-against-terrorists/

Giannini, R. (2010). The rule of law: State sovereignty vs. international obligations. (Old Dominion University). Retrieved from http://al.odu.edu/mun/docs/Issue brief 2010, The rule of law.pdf

Glaser, J. (2013, October 24). Former US Official: For Every Yemen Terrorist US Drones Kill, 40-60 New Enemies Are Created. Anti War Blog. Retrieved from: http://antiwar.com/blog/2013/10/24/former-us-official-for-every-yemen-terrorist-us-drones-kill-40-60-new-enemies-are-created/

Gordon-Bloomfield, N. (2010, October 27). Electric Car Drives 375 Miles at 55 mph, Recharges In 6 Minutes. Retrieved from Green Car Reports: http://www.greencarreports.com/news/1050863_electric-car-drives-375-miles-at-55-mph-recharges-in-6-minutes

Gould, C. (2013, April 2013). Illinois Farm Families Blog. Retrieved from Watch Us Grow: http://www.watchusgrow.org/illinois-farm-families-blog/modern_farm_equipment_gps_and_yield_monitoring

Gounari S. (2012, December 13). EO Satellites vs. UAVs: A High-Resolution Battle. Retrieved from Northern Sky Research: http://www.nsr.com/news-resources/the-bottom-line/eo-satellites-vs-uavs-a-high-resolution-battle/

Greenwald, G. (2012, August 20). US drone strikes target rescuers in Pakistan – and the west stays silent. The Guardian. Retrieved from: http://www.theguardian.com/commentisfree/2012/aug/20/us-drones-strikes-target-rescuers-pakistan

Gross, B. (2013, February 14). MaxSonar Operation on a Multi-Copter. Retrieved from MaxBotix: http://www.maxbotix.com/articles/067.htm

Handwerk, B. (2003, October 24). What Does "Jihad" Really Mean to Muslims? National Geographic News.  Retrieved from: http://news.nationalgeographic.com/news/2003/10/1023_031023_jihad_2.html

Handwerk, B. (2013, December 02). 5 Surprising Drone Uses (Besides Amazon Delivery). National Geographic News. Retrieved from: http://news.nationalgeographic.com/news/2013/12/131202-drone-uav-uas-amazon-octocopter-bezos-science-aircraft-unmanned-robot/

Hero3+. (2014). Retrieved from GoPro: http://gopro.com/cameras/hd-hero3-black-edition

Hess, & Winchester. (1998). Wings of Fame. Ann Arbor: Lowe & B. Hould.

Hoffer, J. (2013, October 18). Exclusive: Brooklyn man arrested for flying drone over Manhattan. Retrieved from ABC Local: http://abclocal.go.com/wabc/story?section=news/investigators&id=9292217

Horgan, J. (2013, March). Unmanned Flight. Retrieved from National Geographic: http://ngm.nationalgeographic.com/2013/03/unmanned-flight/horgan-text

Howard, C. (2013, July 11). UAV command, control & communications. Retrieved from Military & Aerospace Electronics: http://www.militaryaerospace.com/articles/print/volume-24/issue-7/special-report/uav-command-control-communications.html

Hoyle, C. (2013, October 24). ‘We are not drones’: USAF RPA crews fight back. Retrieved March 28, 2014, from http://www.flightglobal.com/blogs/the-dewline/2013/10/drones-usaf-rpa-crews-fight-back/

Huerta, M. P. (2014, February 5). Subcommittee on Aviation, on the FAA Modernization and Reform Act of 2012: Two Years Later. The Committee on Transportation and Infrastructure.

Human Rights Watch. (2014, February). A Wedding That Became a Funeral. Human Rights Watch. Retrieved from: http://www.hrw.org/sites/default/files/reports/yemen0214_ForUpload_0.pdf

International Civil Aviation Organization. (2006).Convention on international civil aviation. Retrieved from website: http://www.icao.int/publications/Documents/7300_cons.pdf

International Human Rights and Conflict Resolution Clinic at Stanford Law School; Global Justice Clinic At NYU School Of Law. (2012, September). Living Under Drones. Retrieved from http://www.livingunderdrones.org/report/

Intrabartola, S. (2011, November 13). Are drones a deterrence? Not really. Times Dispatch. Retrieved from: http://www.timesdispatch.com/news/are-drones-a-deterrence-not-really/article_e849eeba-4087-5241-b274-19b972591a40.html?mode=jqm

Jackson, R. (2005). Writing the war on terrorism. (p. 8). Manchester University Press.

Jenkins, D., & Vasigh, B. (2013, March). The Economic Impact of Unmanned Aircraft Systems Integration in the United States. Arlington: Association for Unmanned Vehicle Systems International.

Jiong, Y. L. (2010). GPS/SINS/BARO Integrated Navigation System for UAV. Retrieved from IEEE Xplore: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5634730&tag=1

Joint Planning and Development Office. (2013). Unmanned Aircraft Systems (UAS) Comprehensive Plan.

K-MAX®. (n.d.). Retrieved March 28, 2014, from: http://www.kaman.com/aerospace/aerosystems/air-vehicles-mro/products-services/k-max/

Kaag, J., & Kreps, S. (2012, July 22). The Moral Hazard of Drones. The New York Times. Retrieved from: http://opinionator.blogs.nytimes.com/2012/07/22/the-moral-hazard-of-drones/?_php=true&_type=blogs&_r=0

Kabbani, S. M., & Hendricks, S. S. (n.d.). Jihad: A Misunderstood Concept from Islam - What Jihad is, and is not. The Islamic Supreme Council of America. Retrieved April 26, 2014, from: http://islamicsupremecouncil.org/understanding-islam/legal-rulings/5-jihad-a-misunderstood-concept-from-islam.html?start=9

Kamkar, S. (2013, December 02). SkyJack. Retrieved from http://samy.pl/skyjack/

Katombe, K. (2013, December 3). U.N. forces use drones for first time, in eastern Congo. Reuters. Retrieved April 22, 2014, from: http://www.reuters.com/article/2013/12/03/us-rop-congo-democratic-drones-idUSBRE9B20NP20131203

Kaufman, L., & Somaiya, R. (2013, November 24). Media and Advertising. Retrieved from The New York Times: http://www.nytimes.com/2013/11/25/business/media/drones-offer-journalists-a-wider-view.html

Kazim, H. (2011, January 21). Striking Back at the US: Relatives of Pakistani Drone Victims to Sue CIA. Spiegel Online. Retrieved from: http://www.spiegel.de/international/world/striking-back-at-the-us-relatives-of-pakistani-drone-victims-to-sue-cia-a-740638.html

Kendall. (2012, June 20). Difference between fixed-wing aircraft and a rotary wing aircraft. Retrieved from AeroLink: http://www.aerolink.es/blog/difference-between-fixed-wing-aircraft-and-a-rotary-wing-aircraft/

Kenyon, H. (2012, March 08). DOD aiming to lift restrictions on unmanned flights in US airspace. Retrieved from GCN: http://gcn.com/articles/2012/03/08/dod-faa-domestic-unmanned-aircraft-flights.aspx

Khattak, R. W., Mohammad, F., & Lee, R. (n.d.). The Pashtun Code of Honour. Retrieved from Central Asia: http://www.asc-centralasia.edu.pk/Issue_65/01_The%20Pashtun_Code_of_Honour.html

Kingcope. (2009). Reading Mission Control Data out of Predator Drone video feeds. Retrieved from Wikileaks: http://wlstorage.net/file/predator-drone-readout-2009.pdf

Kleindienst v. Mandel. (1972, June 29). Retrieved from Leagle:

http://www.leagle.com/decision/19721161408US753_11144.xml/KLEINDIENST%20v.

%20MANDEL

Krasny, R. (2014, March 07). U.S. FAA will appeal ruling on commercial drone use. Retrieved from Reuters: http://www.reuters.com/article/2014/03/07/us-usa-aircraft-drones-idUSBREA261PY20140307

LaCour, B., & Wilson, M. (2013). NextGen - An Update.

LaFleur, J., Government, Media Focus on Commercial Satellite Images. (2003, Summer) Retrieved from  Reporters Committee: http://www.rcfp.org/browse-media-law-resources/news-media-law/news-media-and-law-summer-2003/government-media-focus-comm

LaFranchi, H. (2013, June 3). American public has few qualms with drone strikes, poll finds. The Christian Science Monitor. Retrieved from: http://www.csmonitor.com/USA/Military/2013/0603/American-public-has-few-qualms-with-drone-strikes-poll-finds

Lallanilla, M. (2013, March 24). 8 Totally Cool Uses for Drones. Retrieved from Live Science: http://www.livescience.com/28136-uses-for-drones.html

Lamb, K., & Globe, J. (2014, January 17). Missouri Farmers Consider Using Drones. Retrieved from Ag Web: http://www.agweb.com/article/missouri_farmers_consider_using_drones_NAA_Associated_Press/

Lands, A. (2013). Comment regarding privacy and safety FAA-2013-0061. Cascabel: Cascael Conservation Association.

Lee, N. (2013, November 26). Drone crashes into Sydney Harbour Bridge. Retrieved from MSN: http://news.ninemsn.com.au/national/2013/11/26/18/26/drone-crashes-into-sydney-harbour-bridge

LIDAR—Light Detection and Ranging—is a remote sensing method used to examine the surface of the Earth. (2014). Retrieved from NOAA: http://oceanservice.noaa.gov/facts/lidar.html

LockHeed-Martin RP-3 DarkStar (2014, January 03). Retrieved from National Museum of the US Air Force: http://www.nationalmuseum.af.mil/factsheets/factsheet.asp?id=616

Masood, S., & Mehsud, I. T. (2013, November 23). Thousands in Pakistan Protest American Drone Strikes. Retrieved from The New York Times: http://www.nytimes.com/2013/11/24/world/asia/in-pakistan-rally-protests-drone-strikes.html?_r=0

Mataconis, D. (2012, March 6). Eric Holder: Yes, We Can Kill American Citizens Without Trial. Outside the Beltway. Retrieved April 12, 2014, from http://www.outsidethebeltway.com/eric-holder-yes-we-can-kill-american-citizens-without-trial/

Mazzetti, M. (2014, April 5). Delays in Effort to Refocus C.I.A. From Drone War. The New York Times. Retrieved April 20, 2014, from http://www.nytimes.com/2014/04/06/world/delays-in-effort-to-refocus-cia-from-drone-war.html?hpw&rref=world&_r=0

Memorandum Of Understanding Between Federal Aviation Administration, Unmanned Aircraft Systems Integration Office And The U.S. Department Of Justice, Office Of Justice Programs, National Institute Of Justice Concerning Operation Of Unmanned Aircraft Systems By Law Enforcement Agencies (2013) Retrieved from Airborne Law Enforcement Association: http://alea.org/assets/pressReleases/assets/1805/DOJ%20FAA%20MOU.pdf

Montavalli, J. (2012, August 21). 400-mile Electric Car Batteries Are Around the Corner, Or Not. Retrieved from Plugin Cars: http://www.plugincars.com/future-tech-400-mile-batteries-are-either-vaporware-or-around-corner-123905.html

Moore, A. (2008, November 14). Lithium Polymer (Lipo) Battery Guide. Retrieved from Revolution Robotics: http://revolution-robotics.com/articles/lithium_polymer_lipo_battery_guide

Moore, T. (2013, March 22). 'We're going to have more visibility and less privacy': Mayor Bloomberg admits soon NYPD surveillance cameras will be on nearly every corner and in the air. New York Daily News.

MQ-9 Reaper (2010, August 18). Retrieved from U.S Air Force fact sheets: http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104470/mq-9-reaper.aspx

Mraz, S. (2006, November 09). A surveillance drone you're not likely to see. Retrieved from Machine Design: http://machinedesign.com/news/surveillance-drone-youre-not-likely-see

Non-State Actors in Conflict. (2009). Stockholm International Peace Research Institute. Retrieved April 16, 2014, from http://archives.sipri.org/contents/conflict/nonstateactors.html/view?searchterm=Non-State%20Actors%20in%20Conflict

Noorden, R. V. (2014, March 05). The rechargeable revolution: A better battery. Retrieved from Nature: http://www.nature.com/news/the-rechargeable-revolution-a-better-battery-1.14815

O’Connell, M. (2012). What is war. (Vol. 37). Retrieved from http://www.brill.com/what-war

Pacific Gas & Electric Co. v. Federal Power Commission. (1974). D.C. Circuit.

Pakistan has a clear stance on US drone attacks: Hina. (2013, August 31). The Nation. Retrieved from: http://www.nation.com.pk/national/31-Aug-2012/pakistan-has-a-clear-stance-on-us-drone-attacks-hina

Pakistani Public Opinion Ever More Critical of U.S. (2012, June 27). Pew Research Global Attitudes Project. Retrieved November 28, 2013, from http://www.pewglobal.org/2012/06/27/pakistani-public-opinion-ever-more-critical-of-u-s

Pakistan urges end to drone strikes in UN General Assembly. (2013, November 27). Dawn. Retrieved from: http://www.dawn.com/news/1058935/pakistan-urges-end-to-drone-strikes-in-un-general-assembly

Palmer, A. (2012). From Battlefield to Farm Field. University of North Dakota.

Parrot. (2014). AR.Drone2.0. Retrieved from Parrot: http://ardrone2.parrot.com/

Parsons, D. (2013, November 15). National Defence. Retrieved from National Defence Blog: http://www.nationaldefensemagazine.org/blog/Lists/Posts/Post.aspx?ID=1334

Pedlow & Welzenbach, (1992). Reconnaissance. Retrieved December 19, 2013, from http://intellit.muskingum.edu/recon_folder/reconplanes_folder/reconplanespedlow.html

Pilkington, E., & Devereaux, R. (2013, October 25). US defends drone strikes as 'necessary and just' in face of UN criticism. Retrieved December 15, 2013, from http://www.theguardian.com/world/2013/oct/25/un-drones-us-policy-debate.

Pincus, W. (2002, November 6). US Missiles Kill al Qaida Suspect. Retrieved from The Age: http://www.theage.com.au/articles/2002/11/05/1036308311314.html

Private Pilot Course Sections (2014). Retrieved from FAA Ground School: http://www.faa-ground-school.com/Lessons.aspx?id=1

Promote Ag Day. (2014). Retrieved from Ag Day: http://www.agday.org/media/factsheet.php

Radia, A. (2012, August 7). Canadian military to spend $1 billion on unmanned armed drones. Yahoo! News. Retrieved April 22, 2014, from https://ca.news.yahoo.com/blogs/canada-politics/canadian-military-spend-1-billion-unmanned-armed-drones-181629244.html

Rayment, S. (2009, March 21). RAF bomb the Taliban from 8,000 miles away. Retrieved from The Telegraph: http://www.telegraph.co.uk/news/worldnews/asia/afghanistan/5027462/RAF-bomb-the-Taliban-from-8000-miles-away.html

RCgroups. (2012, September 04). Quadcopter Build. Retrieved from RCgroups Forum: http://www.rcgroups.com/forums/showthread.php?t=1725574

Reaper. (n.d.). Royal Air Force. Retrieved March 8, 2014, from: http://www.raf.mod.uk/equipment/reaper.cfm

Remarks by the President at the National Defense University. (2013, May 23). The White House. Retrieved from: http://www.whitehouse.gov/the-press-office/2013/05/23/remarks-president-national-defense-university

Rivera, J. (2013, November 27). Fast Company. Retrieved from Fast Colabs.

Robinson, L. (2013, October 31). The Downside of Drones. USNews. Retrieved April 21, 2014, from http://www.usnews.com/opinion/blogs/world-report/2013/10/31/drone-strikes-arent-always-the-most-effective-counterterrorism-measure

Rogers, S. (2012, August 3). Drones by country: who has all the UAVs? Retrieved from The Guardian: http://www.theguardian.com/news/datablog/2012/aug/03/drone-stocks-by-country

Roggio, B., & Mayer, A. (2014). Charting the data for US airstrikes in Pakistan, 2004 - 2014. The Long War Journal. Retrieved April 10, 2014, from: http://www.longwarjournal.org/pakistan-strikes.php

RoseMary. (2010). Microcontrollers. Retrieved from Engineers Garage: http://www.engineersgarage.com/microcontroller

RT. (2014, April 06). Military drone crashes near Pennsylvania elementary school. Retrieved from RT: http://rt.com/usa/military-drone-crashes-pa-school-501/

Sabatini, N. (2007, February 6). Unmanned Aircraft Operations in the National Airspace System. Federal Aviation Administration (FAA). Washington D.C.

Sanction. (2014). In Merriam-Webster.com. Retrieved April 29, 2014, from http://www.merriam-webster.com/dictionary/sanction.

Schroyer, M. (2012, July 3). A code of ethics for drone journalism. Retrieved from DIY Drones: diydrones.com/profiles/blogs/a-code-of-ethics-for-drone-jounalism

Scovel III, C. L. (2014, February 5). FAA's Implementation of the FAA Modernization and Reform Act of 2012 Remains Incomplete.

Scovel, C. (2014, Feb 06). FAA: Drone flight approvals not likely for years. Retrieved from http://www.newsmax.com/US/faa-drone-flights/2014/02/06/id/551284/

Serle, J. (2014, March 12). Countries must investigate civilian drone death claims. The Bureau of Investigative Journalism. Retrieved April 18, 2014, from http://www.thebureauinvestigates.com/2014/03/12/countries-must-investigate-civilian-drone-death-claims-says-un-investigator-ben-emmerson/

Shane, S. (2011, August 11). C.I.A. Is Disputed on Civilian Toll in Drone Strikes. The New York Times. Retrieved from: http://www.nytimes.com/2011/08/12/world/asia/12drones.html?pagewanted=all&_r=0

Sharkey, Noel. (2012). Researchers Use ‘Spoofing’ to Hack into a Flying Drone. Retrieved from BBC News: http://www.bbc.co.uk/news/technology-18643134

Shaw, Ian G. R. (2013), “The Rise of the Predator Empire: Tracing the History of U.S. Drones”, Retrieved from Understanding Empire: http://understandingempire.wordpress.com/2-0-a-brief-history-of-u-s-drones/

Siddiqui, S. (2013, April 24). Obama 'Surprised,' 'Upset' When Anwar Al-Awlaki's Teenage Son Was Killed By U.S. Drone Strike. The Huffington Post. Retrieved April 21, 2014, from http://www.huffingtonpost.com/2013/04/23/obama-anwar-al-awlaki-son_n_3141688.html

Slade, S. (2009). Feel the G's: The Science of Gravity and G-Forces. Headline Science.

Sovereignty. (n.d.) In Black's Law Dictionary. Retrieved from http://www.hawaii-nation.org/sovereignty.html

Spritzler, J. (2012, November 24). Drones Create Hatred of the U.S., Which Is Their Real Purpose. New Democracy World. Retrieved from: http://newdemocracyworld.org/war/drone_print.html

Stafford, D. (2009, September 29). VeraTech Phantom Sentinel and the Scroton revisited Retrieved from Rocket Dungeon: http://rocketdungeon.blogspot.com/2009/09/veratech-phantom-sentinel-and-scroton.html

Stanley, J. (2013, May 20). 'Drone' vs 'UAV' -- What's Behind a Name. American Civil Liberties Union. Retrieved from https://owl.english.purdue.edu/media/pdf/20110928111055_949.pdf

Stokes, B. (2013, JUly 25). Big gender gap in global public opinion about use of drones. Retrieved from Fact Tank: http://www.pewresearch.org/fact-tank/2013/07/25/big-gender-gap-in-global-public-opinion-about-use-of-drones/

Strawser, B. (2012, August 6). The morality of drone warfare revisited. The Guardian. Retrieved from: http://www.theguardian.com/commentisfree/2012/aug/06/morality-drone-warfare-revisited

Subbaraman, N. (2013, March 30). NBC News. Retrieved from NBC News Technology.

Subtitle B-Unmanned Aircraft Systems. (2012, February 14). FAA Modernization and Reform Act of 2012. United States of America.

Swanson, E. (2013, February 15). Opinion On Drones Depends On Who's Being Killed: Poll. The Huffington Post. Retrieved from: http://www.huffingtonpost.com/2013/02/15/drones-opinion_n_2689813.html

Tahir, M. (Director). (2014). Wounds Of Waziristan [Motion Picture].

Taylor, J. W., & Munson, K. (1977). New York: Collier Books.

The Security Council. (2014). United Nations Security Council. Retrieved April 22, 2014, from http://www.un.org/en/sc/

The Universal Declaration of Human Rights. (n.d.). The United Nations. Retrieved April 16, 2014, from: http://www.un.org/en/documents/udhr/

Thirty years of America's Drug War. (2014). PBS. Retrieved April 16, 2014, from http://www.pbs.org/wgbh/pages/frontline/shows/drugs/cron/

Toor, A. (2010, October 19). Why are Customary Pashtun Laws and Ethics Causes for Concern? Blog. Retrieved from Center for Strategic and International Studies: http://csis.org/blog/why-are-customary-pashtun-laws-and-ethics-causes-concern

Treaties and States Parties to Such Treaties. (n.d.). The International Committee of the Red Cross. Retrieved April 14, 2014, from: http://www.icrc.org/applic/ihl/ihl.nsf/ART/365-570006?OpenDocument

Trimble. (2014). Surveyors Do It Differently. Retrieved from GPS tutorial: http://www.trimble.com/gps_tutorial/sub_adv.aspx

Tyson, J. (2001, April 27). How Night Vision Works. Retrieved from How Stuff Works: http://electronics.howstuffworks.com/gadgets/high-tech-gadgets/nightvision2.htm

Tyson, P. (2007, October 07). All About G Forces. Retrieved from Nova: http://www.pbs.org/wgbh/nova/space/gravity-forces.html

United States v. Jones. (2012, January 23). Retrieved from FindLaw: http://caselaw.lp.findlaw.com/scripts/getcase.pl?court=US&vol=000&invol=10-1259

Unmanned Aerial Vehicles (UAV): Drones for Military and Civilian Use. (2014, March 21). Retrieved from Global Research News: http://www.globalresearch.ca/unmanned-aerial-vehicles-uav-drones-for-military-and-civilian-use/5374666

U.S. Air Force. (2008, October). RQ-4 Global Hawk Unmanned Aircraft System. Retrieved from Air Force Link: http://web.archive.org/web/20081028210413/http://www.af.mil/factsheets/factsheet.asp?fsID=13225

U.S. Department of Energy. (2012). Sodium-Ion Batteries for Grid-Level Applications. Washington D.C.

Vehicle. 2014. In Merriam-Webster.com. Retrieved March 18, 2014, from http://www.merriam-webster.com/dictionary/vehicle

Vinik, D. (2012, March 6). What Are Economic Sanctions and How Would They Affect the Crisis in Ukraine? New Republic. Retrieved April 16, 2014, from http://www.newrepublic.com/article/116908/definition-and-explanation-us-economic-sanctions-against-russia

War. 2014. In Merriam-Webster.com. Retrieved April 8, 2014, from http://www.merriam-webster.com/dictionary/war

War and international humanitarian law. (2010, October 29). The International Committee of the Red Cross. Retrieved from: http://www.icrc.org/eng/war-and-law/overview-war-and-law.htm

War Zone. (2014). In Uslegal.com. Retrieved from http://definitions.uslegal.com/w/war-zone%20/

War on terrorism. (n.d.). Retrieved from http://www.globalpolicy.org/war-on-terrorism.html

Warren, L. M. (2013, November 7). Retrieved from Federal Aviation Administration: http://www.faa.gov/about/initiatives/uas/media/UASTS_RFC_FR_notice_2-14-2013.pdf

Weinberger, Sharon. (2012). 4 Drone Sensors That Changed Warfare - and What Happens When They Come Home. Retrieved from Popular Mechanics: http://www.popularmechanics.com/technology/military/planes-uavs/4-new-drone-sensors-that-changed-warfare-and-what-could-happen-when-they-come-home-9549377#slide-1

What is GPS? (2014). Retrieved from Garmin: http://www8.garmin.com/aboutGPS/

Whitlock, C. (2013, October 22). Drone strikes killing more civilians than U.S. admits, human rights groups say. The Washington Post. Retrieved from: http://www.washingtonpost.com/world/national-security/drone-strikes-killing-more-civilians-than-us-admits-human-rights-groups-say/2013/10/21/a99cbe78-3a81-11e3-b7ba-503fb5822c3e_story.html

Whittle, R. (2013, April). The Man Who Invented the Predator. Retrieved from Air & Space Smithsonian: http://www.airspacemag.com/flight-today/the-man-who-invented-the-predator-3970502/?no-ist

Wilkinson, I. (2009, May 24). Pakistani troops gain upper hand in key Swat town. The Telegraph.

Womens International League for Peace and Freedom (2013). Outer Space. Reaching Critical Will. Retrieved February 16, 2014, from http://www.reachingcriticalwill.org/resources/fact-sheets/critical-issues/5448-outer-space

Woods, C. (2013, October 26). Consensus grows among UN states for greater transparency on drone civilian deaths. The Bureau of Investigative Journalism. Retrieved April 20, 2014, from http://www.thebureauinvestigates.com/2013/10/26/consensus-grows-among-un-states-for-greater-transparency-on-drone-civilian-deaths/

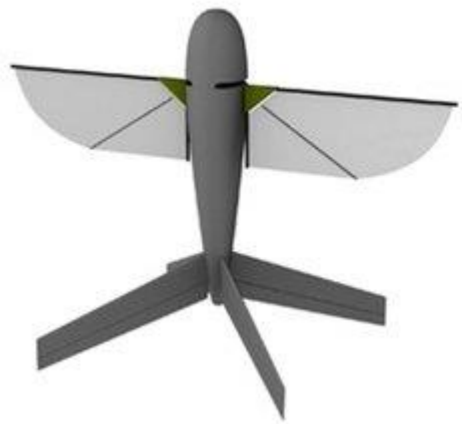
Zaheer, K. (2013, November 22). Definition of a shaheed. Dawn. Retrieved from: http://www.dawn.com/news/1057801/definition-of-a-shaheed

Zenko, M. (2013, January). Reforming U.S. drone strike policies. Retrieved from http://www.cfr.org/wars-and-warfare/reforming-uzsz-drone-strike-policies/p29736

## Appendix A: Acronyms

| Acronym | Meaning |
|---|---|
| ARL | Air Force Research Lab |
| ATO | Air Traffic Organization |
| AUVSI | Association for Unmanned Vehicle Systems International |
| CIA | Central Intelligence Agency |
| COA | Certificate of Authorization |
| DHS | Department of Homeland Security |
| DoD | Department of Defense |
| DoE | Department of Energy |
| DOJ | Department of Justice |
| FAA | Federal Aviation Administration |
| FATA | Federally Administered Tribal Area |
| FMRA | FFA Modernization and Reform Act of 2012 |
| FPV-RC | First Person View Remote Control |
| GBSAA | Ground Based Sense And Avoid Systems |
| GPS | Global Positioning System |
| HD | High Definition |
| IACP | International Association of Chiefs of Police |
| IR | Infrared |
| ISTAR | Intelligence, Surveillance, Target Acquisition, and Reconnaissance |
| JPDO | Joint Planning and Development Office |
| LIDAR | Light Detection and Ranging |
| MNA | Member of National Assembly |
| MPH | Mile Per Hour |
| NASA | National Aeronautics and Space Administration |
| NextGen | Next Generation Air Transportation System |
| NGO | Non-Government Organization |
| NOAA | National Oceanic and Atmospheric Administration |
| NPRM | Notice of Proposed Rulemaking |
| NSA | National Security Agency |
| PID | Proportional Integral Derivative |
| R&D | Research and Development |
| ROA | Remotely Operated Aircraft |
| RPA | Remote Piloted Aircraft |
| sUAS | small Unmanned Aircraft System |
| TBIJ | The Bureau of Investigative Journalism |
| UA | Unmanned Aircraft |
| UAS | Unmanned Aerial System |
| UAV | Unmanned Aerial Vehicle |
| US | United States (of America) |
| USA | United States of America |
| VTOL | Vertical Take-Off and Landing |

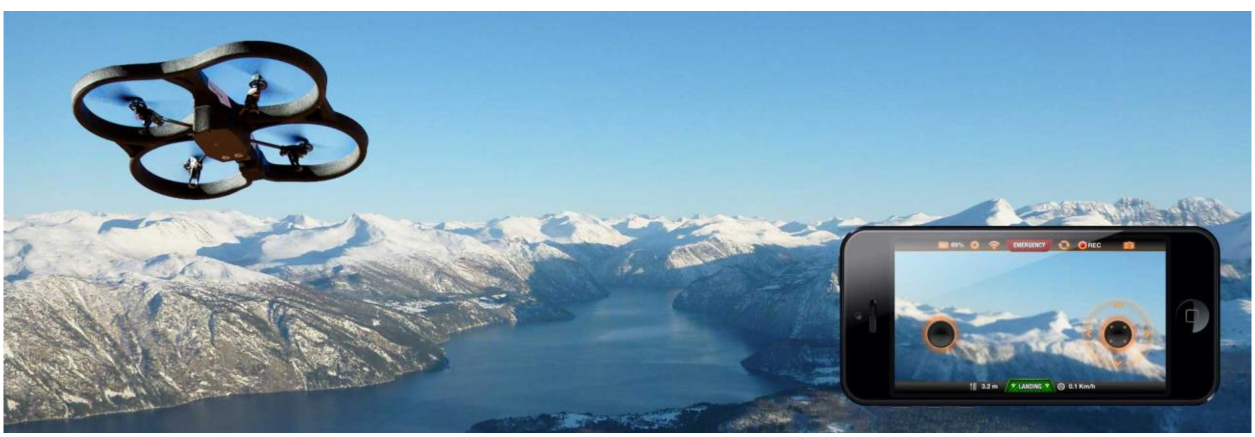
# Appendix B: RPA Images



Smallest UAV (Covert, 2008)

Global Hawk, The World’s Largest UAV (Ching-Ching, 2005)

MQ-1 Predator Drone, the world’s most famous drone (Valdes, 2004)




Parrot Ar-2 (Frugal, 2013)

Draganflyrer X-6 (RCReview, 2011)

Phantom Sentinel, the only known spinning RPA (Mraz, 2006)

## Appendix C: Polls

*Do you think the U.S. government should or should not use drones to -- ?*

Among national adults

| | % Yes, should | % No, should not | % No opinion |
|---|---|---|---|
| Launch airstrikes in other countries against suspected terrorists * | 65 | 28 | 8 |
| Launch airstrikes in other countries against U.S. citizens living abroad who are suspected terrorists * | 41 | 52 | 7 |
| Launch airstrikes in the U.S. against suspected terrorists living here ** | 25 | 66 | 9 |
| Launch airstrikes in the U.S. against U.S. citizens living here who are suspected terrorists ** | 13 | 79 | 7 |

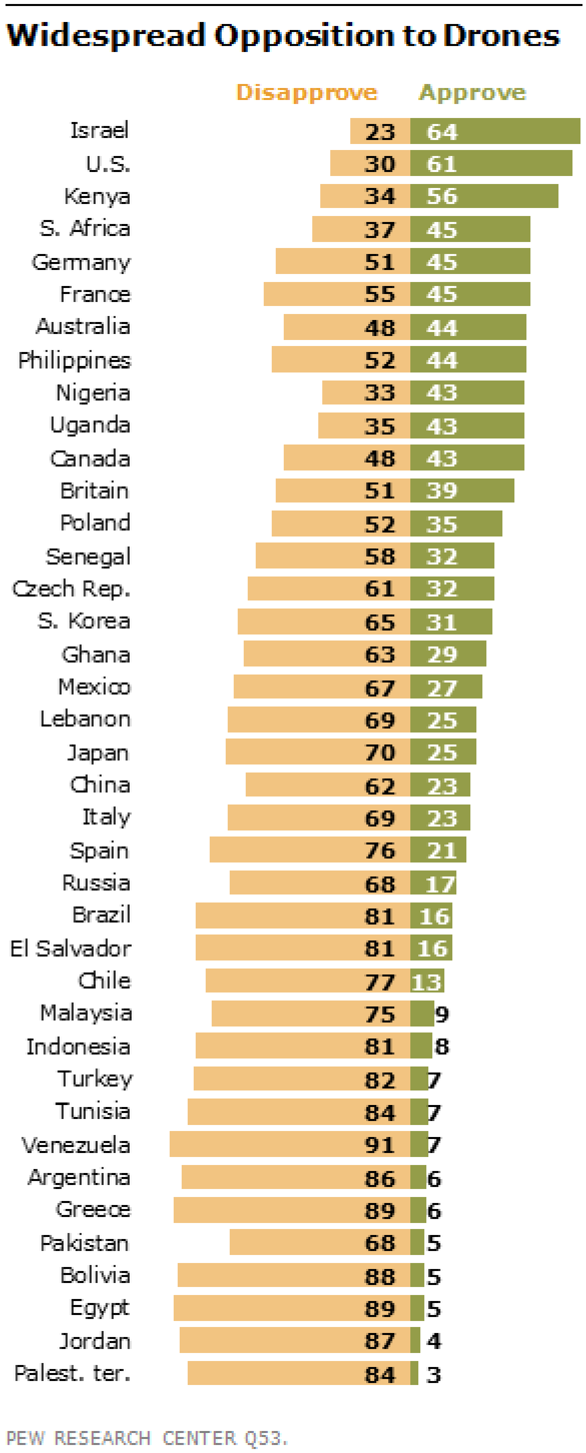
* Based on Sample A of 502 national adults

** Based on Sample B of 518 national adults

March 20-21, 2013

GALLUP

Gallup (2013) poll regarding drone strikes (Brown & Newport, 2013).




Global opinion of the United States' drone strikes ("Chapter 1. Attitudes," 2013).

| | A great deal | Some | Just a Little | Nothing at all | | |
|---|---|---|---|---|---|---|
| **Public Awareness of Unmanned Aircraft** | 17% | 39% | 26% | 18% | | |
| | | | | | | |
| | **Use in U.S.** | **Homeland Security** | **Fight Crime** | **Search & Rescue** | **Commercial** | **Everyday Use** |
| **Public Support By Type of Use** | 57% | 67% | 63% | 88% | 61% | 43% |
| | | | | | | |
| | **Used to Monitor Outside** | **Safety** | **Government Ability to Regulate** | | | |
| **Public Concerns** | 67% | 65% | 75% | | | |
| | | | | | | |
| | **Traffic** | **Photo Flight** | **Drug Locate** | **Search & Rescue** | **Emergency Response** | **Invetigate** |
| **Possible Applications Reported by Law Enforcement** | 26% | 81% | 73% | 93% | 66% | 72% |
| | | | | | | |
| | **Human Resources** | **Cost** | **Search & Seizure** | **Safety** | **Privacy Pushback** | **FAA Regulations** |
| **Law Enforcement Concerns** | 31% | 79% | 68% | 58% | 65% | 25% |

## Appendix D: Classification of RPAs

Note: All of these figures come from the same report from Dr. Maziar Arjomandi from the University of Adelaide (2006).

| Classification by Weight | | |
|---|---|---|
| **Designation** | **Weight Range** | **Example** |
| Super Heavy | >2000 kg | Global Hawk |
| Heavy | 200 – 2000 kg | A-160 |
| Medium | 50 – 200 kg | Raven |
| Light | 5 – 50 kg | RPO Midget |
| Micro | <5 kg | Dragon Eye |

| Range and Endurance | | | |
|---|---|---|---|
| **Category** | **Endurance** | **Range** | **Example** |
| High | >24 hours | >1500km | Predator B |
| Medium | 5 – 24 hours | 100 – 400 km | Silver Fox |
| Low | < 5 hours | < 100 km | Pointer |

| **Classification by Maximum Altitude** | | |
|---|---|---|
| **Category** | **Max Altitude** | **Example** |
| Low | < 1000 m | Pointer |
| Medium | 1000 – 10000 m | Finder |
| High | > 10000 m | Darkstar |

Engine Type

| UEL Rotary | Turbofan | Two-stroke | Piston | Turboprop | Electric | Push & Pull | Prop |
|---|---|---|---|---|---|---|---|
| Outrider | Global Hawk | Pioneer | Predator | Predator B | Dragon Eye | Hunter | LEWK |
| Shadow | Darkstar | RPO Midget | Neptune | | FPASS | | Sperwer |
| Shadow 600 | Phoenix | | Dragon Drone | | Dragon Warrior | | |
| Cypher | X-45 | | Finder | | Pointer | | |
| | X-50 | | A 160 | | Raven | | |
| | Fire Scout | | GNAT | | Luna | | |
| | | | Crecerelle | | Javelin | | |
| | | | Seeker | | | | |
| | | | Brevel | | | | |
| | | | Snow Goose | | | | |
| | | | Silver Fox | | | | |
| | | | Heron | | | | |

According to the UAV Roadmap 2002, mission capabilities can be divided into the following categories:

- Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR)
- Combat (UCAV)
- Multi-Purpose
- Vertical Take-Off and Landing (VTOL)
- Radar and Communication Relay
- Aerial Delivery and Resupply

# Appendix E: FAA Progress

| Section in | Description | Deadline | Status | Details |
|---|---|---|---|---|
| 334c | Simplify COA Process | 5/14/2012 | 3/29/2012 | Doubled length of Authorization for COAs to 24 months |
| 334c | Establish agreements to expedite COAs | 5/14/2012 | 3/4/2013 | Estalished MOU with other goverment agencies |
| 332c(1) | Start program for six test site | 8/12/2012 | 12/30/2013 | FAA has announced Test site selections |
| 332d | designate permanent area for Arctic sites where UAVs may operate | 8/12/2012 | 11/1/2012 | FAA arctic plan signed November, but released on website in December |
| 333 | Determine if UAS can operate safely in NAS before the Comprehensive Plan is complete | 8/12/2012 | 7/19/2013 | FAA issued restricted category certifications to RPAs to operate in the Arctic |
| 332a(1) | Develope a Comprehensive Plan for integrating UAS into NAS | 11/10/2012 | 9/1/2013 | Document had to undergo interagency review proces |
| 334a | Issue guidlines for operation of RPAs by goverment and public entities, expedite COAs | 11/10/2012 | 1/22/2013 | FAA issued Notice N8900.207 to provide policies fro reviewing COA applicants and outline best practices for RPA operations |
| 332a(4) | Submit Comprehensive Plan to Congress | 2/14/2013 | 11/6/2013 | Submitted late due to interagency review process |
| 332c(4) | Make one test site operational | 2/14/2013 | In Progress 6/1/2014 | FAA says first site will not be operational until June 2013 |
| 332a(5) | Develope 5-year roadmap | 2/14/2013 | 11/7/2013 | document underwent Legislative Referral Memorandum process |
| 332b(3) | Issue update to Administration's policy statement on UAS | 8/14/2014 | Deadline in Future | |
| 332b(1) | Issue Final Rule on sUAS | 8/14/2014 | Deadline in Future | FAA will be unable to meet deadline |
| 332b(2) | Issue NPRM to implement Comprehensive Plan | 8/14/2014 | Deadline in Future | |
| 332a(3) | Safe integration of civil RPAs into NAS | 9/30/2015 | Deadline in Future | FAA plans to have test sites operational, issue small RPA rule, and approve ground based detect-and-avoid system for cerain RPAs |
| 332b(2) | Issue final Rule on integration of all RPA into NAS | 12/14/2015 | Deadline in Future | |
| 334b | implement operational and certification requirements for operation of goverment and non-profit organizations RPAs into NAS | 12/31/2015 | Deadline in Future | |
| 332c(1) | Terminate program for six test sites | 2/14/2017 | Deadline in Future | |
| 332c(5) | Submit report of findings and conclusions from six test site | 5/15/2017 | Deadline in Future | |
| | | | | |
| Red | Severly late, nine months to over a year | | | |
| Green | On time | | | |
| Orange | Late, but nine months or less | | | |

## Appendix F: Interview Overviews

| Name | Position | Overview |
|---|---|---|
| Bianchi, Andrea | Project Manager at NUAIR | She is at Griffis air base, a FAA test site where they primarily work on detect and avoid systems. She was interested in public outreach stating that there had been some people upset by the test site status. |
| Chen, YangQuan | Prof. University of California | Professor Chen had short answers with interesting views. His concern was not privacy, but safety. He was critical of people who feared drone use. |
| Cooper, Diana | Lawyer, Canada | She is a privacy and technology lawyer who flies a parrot drone recreationally. She was helpful in clearing up some misconceptions about the Canadian drone program. Recommended further contacts as well as explained privacy by design and its applications. |
| Ford, Tim | president of AeroUAVs | Currently the President of AeroUAVs, which is a part of a larger company that sends pilots to different locations based on where they are needed. AeroUAVs is a spinoff of that concept, to allow the same operation with RPA operators as well as RPAs themselves. These are future plans as AeroUAVs does not violate the FAA's ban on commercial use of RPAs. Talked about the COA process and different partnerships with public entities. Also gave views from an industry perspective on the FAA's progress and privacy concerns. |
| Gibson, Jennifer | Reprieve, UK | Jennifer, a US lawyer, leads Reprieve's drones work in Pakistan. Jennifer has testified about her work before both the US Congress and British Parliamentarians. In 2012, she led a delegation of Pakistani drone victims to the US, where for the first time US Congressmen and women heard testimony from those directly affected by drones. Prior to joining Reprieve, Jennifer was at Stanford University, where she co-authored, Living Under Drones - one of the most comprehensive accounts of the impact of drones in Pakistan to date. |
| Greene, Jon | Virginia Tech test Site | Currently in charge of the Virginia Tech RPA test site program, one of the six locations chosen by the FAA to be used as a testing site. Responded to questions through email and expressed a positive outlook for future RPA uses. Discussed the local public's reaction to test site status as well as what the FAA had requested from Virginia Tech. Also explained the test sites privacy policies and planned uses for RPAs |
| Jason Ryan | MIT Humans and Automation Lab | Jason Ryan provided a technical view of UAVs as well a look into how the scientific community views the FAA. He was quick to show his disdain for the FAA's pace as well as poor understanding of drones. He is hopeful for the future uses of drones and declared that UAVs will be able to do anything a human pilot can do and more. |

| | | |
|---|---|---|
| Jones, Faye | Florida Lawyer, Spoke at Drone Conference | Ms. Jones is hopeful of the future of drone use but wary of its potential for privacy infringement. She worries that both the police and public would infringe on privacy because there are no modern and effective laws preventing it. She did not think the FAA was up to the task of regulating drones in terms of privacy and thought privacy should be handled by a different group, possibly the Dept. of Justice. Thought that the public would need to decide on what level of privacy they wanted as many other technologies had already diminished the amount of privacy available. Was very excited about the possible environmental benefits that RPAs offer. |
| Khavari, Michael | Rutherford Institute | Michael Khavari was the first person we talked to whom harbors primarily anti-drone views. He represents the Rutherford Institute, a libertarian organization that focuses on defending individual rights. The RU is responsible for local legislation in Texas and Virginia that limits the police's ability to record and use UAV footage in court cases. He is also very opposed to arming domestic UAVs. He wants to see new privacy laws written for the modern world as previous laws are not equipped for the technology we now have. Also recommended a privacy discussion at either the state or local levels instead of a national ruling. |
| LeMieux, Dr. (Col Ret) Jerry | Administrator and President, UAV University | Dr. LeMieux had much to say on the economic and commercial benefits of UAV technology. He was quick to condemn the FAA for their slow pace and claimed that the United States was 20 years behind the rest of the world because of public perception and government over-regulation. His specialty was drone use in agriculture. He was first and foremost a businessman and discussed his University's programs that specialized in training RPA operators. |
| Milavich, Barry | chairman of research compliance committee | Is the president of the research compliance committee for University of North Dakota, the committee has members from a broad range of people including local government, police, firefighters, farmers, as well as professors from both the legal and engineering departments. He spoke about how the committee had worked to decide on standards for RPA flights on a local level, and some of the scenarios and uses that had been approved by the committee. Discussed the COA process and the test site selections, as well as recommending some possible ways RPAs could be implemented using a community based approach. |

| | | |
|---|---|---|
| Roby, Don | Aviation Chair, International Chiefs of Police | Mr. Roby provided a clearer look into how law enforcement hopes to use UAVs as simply another ‘tool in the toolbox’. He, like his colleague (Michael Fergus), expressed an interest in educating the public about how the police would utilize UAV technology. He was quick to point out that all non-essential information taken by a drone use would be quickly discarded and any evidence would be kept secure. He made it clear that the problems facing UAVs, while a new technology, are actually the culmination of many older technologies, such as cyber warfare and recording equipment. |
| Schroyer, Matt | Creator of DroneJournalism .org | Matt is both a journalist and a part-time engineer as well as the youngest person we talked to. We discussed: how drones may be used in photography, the basics of building a drone/ using one, and how different generations are dealing with emerging technology. Matt was informative and open to a follow-up interview later down the road. |
| Takahashi, Timothy | Prof. Aerospace & Tech Law | He answered questions regarding the legal perspective of drone use and the laws surrounding some concerns regarding drone use. |
| Valler, Mike | MESA Foam Fighters | Mike works at the sheriff's office but volunteers to teach underprivileged youth about first person flight. He uses UAVS to teach children math and science. He wants to work with high school students to use UAVs to help farmers. Not only was he using UAVs in an unorthodox way, but he was building them very cheaply. He was critical of people misusing or weaponize UAVs, saying they are making it harder for everyone else. He has a partner in Arizona who is working at a high school teaching kids how to build UAVs. He supplies Mike with parts. |
| Wazir, Ayesha Gulalai | Member of Pakistan National Assembly | She is a member of the National Assembly of Pakistan and is a part of the political party Pakistan Tehreek-e-Insaaf (PTI). She belongs to Waziristan Agency where most of drone strikes happened in the past years. In her interview she talked about the effects these drone strikes are having on the people of the region and how it is harming not only the peace process but also the war on terror. She mentioned how drone strikes are increasing militants. Then she talked about alternatives to drone strikes which included peace talks with the tribal elders. |